CAVE Painting: The Integration of Oil Painting with Three Dimensional Computer Generated Environments

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Certification

I certify that except where due acknowledgement has been made, the work is that of the candidate alone; and the whole work has not been submitted previously, in whole or part, to qualify for any other academic award; and the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program.

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ABSTRACT

This thesis explores the integration of oil painting with three dimensional computer generated immersive environments in a multimedia installation called CAVE Painting. This installation is made of two dimensional oil painting done from live models, and three dimensional computer animation using digitised textures derived from the oil paintings. It is presented on four large visual screens arranged in a cube, into which the viewer enters, and is semi immersed inside the work. The oil paintings and the three dimensional computer animations are seamlessly integrated to produce a unified pictorial space.

The history of two dimensional and three dimensional pictorial space has been examined in attempting to understand how oil painting and the three dimensional computer virtual environments have influenced each other. It was shown how Euclid's theorem of parallel lines converging at a vanishing point, was adopted in the Renaissance by Leon Battista Alberti, in developing the rules of two dimensional perspective. This system of representing two dimensional pictorial space was based on a geometrical and mathematical ordering of space. This system allowed for the illusion of three dimensional space on a two dimensional picture plane, such as a canvas. Objects and figures recede into space, conforming to parallel lines that converge at a vanishing point on a horizon line.

Working within this tradition of Renaissance perspective, the oil paintings were constructed for the multimedia installation comprising of portraits of the human head. It was found that this system of perspective, representing illusory three dimensional space, was limiting in that it created a non organic approach to representing the human head. An intuitive and gestural approach was used to challenge this system. A critique of Renaissance perspective by Erwin Panofsky, an art historian, was helpful in challenging the linear depiction of two dimensional pictorial space. He views two dimensional pictorial space as curvilinear. The techniques of contemporary figurative painters, Frank Auerbach and Lucian Freud, were used as a guide in creating a unified, organic and immediate response to the live model. Auerbach's and Freud's techniques focus on depicting the subtle movements of the subjects' flesh using oil paint in a textural and layered way. My portraits represented an intuitive and organic approach to representing the live models. These portraits were then incorporated into the three dimensional computer generated environments.

It was seen that Euclid's theorem, Renaissance perspective and Rene Descartes' Cartesian coordinate system have given rise to the creation of three dimensional computer generated space. Three dimensional computer generated space uses the xyz coordinates of the Cartesian coordinate system. This allows for the depiction of illusory three dimensional space

on a computer screen. This three dimensional pictorial space is not fixed and can be animated over time. Three dimensional computer software was used to construct the three dimensional computer generated environments for CAVE Painting. The portraits were digitised, and then incorporated into the three dimensional environments.

Char Davies, a multimedia artist, was examined as a case study in how to integrate oil painting with three dimensional computer generated environments. She produces immersive virtual reality environments based on the natural world. She has a background as a painter, and is interested in animating the brushstroke in her three dimensional environments. She produces virtual landscapes where the forms are dissolved into each other to provide a unified pictorial space. In the three dimensional immersive environments in CAVE Painting, I have created a unified pictorial space by using transparent digital painting textures. Davies also uses transparency to create a unified pictorial space merging the foreground with the background. Lev Manovich, a current media historian, proposes that three dimensional space is void and made up of separate objects. This premise was challenged by creating a unified pictorial space.

Finally, I combined the portraits done from the live models with the three dimensional computer generated environments. This was achieved by using a Cave Audio Visual Environment (CAVE), defined by Laurie McRobert as a cube where virtual images are projected on the walls, floor and ceiling. This was to illicit a semi immersive sensation in the viewer. However in CAVE Painting, no attempt was made to project upon the ceiling and floor. This was to reinforce the real physical space that CAVE Painting resided in. I have used Paul Milgram and Fumio Kishino's mixed reality theory to guide me in combining the real painting with the three dimensional immersive environments. Milgram and Kishino define mixed reality as a merging of the real and the virtual. The portrait represented the real and tactile object, and the three dimensional immersive environments a virtual light-based immaterial medium. It was shown in CAVE Painting that there can be a seamless integration of two dimensional and three dimensional pictorial space.

CHAPTER ONE

1. Introduction and Review of Literature

1.1 Description of Project

My project is a multimedia artwork comprised of four oil paintings and four three dimensional computer animations, and it will be called CAVE Painting. I aim to semi immerse the viewer in this hybrid of two dimensional and three dimensional pictorial space, displaying it in a real space that surrounds the viewer. I will project the three dimensional imagery on four large visual screens suspended from the ceiling in a cube formation. The paintings will sit in the centre of the visual screens suspended from the ceiling. The sides of the visual screens will be open to allow the viewers to enter, and once inside the hollow cube, they will be surrounded by the imagery in three hundred and sixty degrees.

To achieve my goal, I need to investigate methods for the integration of two dimensional oil paintings on canvas with three dimensional computer generated environments. The oil paintings and the three dimensional computer generated environments will be seamlessly integrated to produce one art-form, wherein the viewer is able to have a semi immersive experience. The oil paintings will be portraits of human heads, whereas the three dimensional computer generated environments will be digital textures derived from the portraits. The oil paintings will be done from live models. The three dimensional environments will be constructed with three dimensional game engine software used in creating three dimensional computer games. The textures of the oil paint in the portraits will be digitised, and imported into the three dimensional computer generated environment. The three dimensional computer generated environments will be projected onto large visual screens, and over the oil paintings hanging in front of the visual screens.

The four oil paintings will portray human subjects, and will be executed in reference to the live models. Unreal game engine software will be employed to build abstract, light based three dimensional immersive environments. The three dimensional computer generated environments will be projected onto the portrait paintings and large visual screens via projectors. The projectors will be attached to computers running the Unreal software. I am able to use this software to animate the textures derived from the portraits in three dimensional computer space. The three dimensional environment will consist of three layers of paint textures digitally sampled from the portrait. These will be positioned at regular intervals in the three dimensional computer space. There will be four individual portraits, each with its corresponding three dimensional digital projections, arranged in a cube formation suspended from the roof inside a darkened room. The viewer will be able to enter this cube from the side, giving a three hundred and sixty degrees view of the installation. A soundscape

will be built using digitised piano chords and notes, and be incorporated into the three dimensional game engine software, and will be played along with the projections in real-time.

1.2 Background to Research

How are we to understand pictorial space that combines traditional and new imaging technology? This question will be examined by looking at theories of two dimensional and three dimensional pictorial space. In regards to two dimensional pictorial space, I will examine Euclid's theorem of parallel lines, an analysis of Renaissance perspective by Leon Battista Alberti in his text *Della Pittura* (tran:1966), and a critical analysis of perspective by Erwin Panofsky in his text, *Perspective as Symbolic Form* (tran:1991). In regard to three dimensional computer generated pictorial space, I will examine Rene Descartes' Cartesian coordinate system, and Lev Manovich's critique of three dimensional computer space in his text *The Language of the New Media* (2001). I will explore how Renaissance perspective rules have led to the development of three dimensional computer generated pictorial space. These two and three dimensional systems of pictorial space describe the illusion of three dimensional space, based on mathematical and geometric rules or systems.

The next step will be to develop techniques used to construct a portrait from the live model that will be integrated with three dimensional immersive environments. The work of contemporary English painters Lucian Freud and Frank Auerbach will be examined, using art historian Robert Hughes' analyses of these artists as a guide to constructing the portraits. These artists work only from the live model and use the oil paint in a textural way to reinforce the illusion of three dimensional form, and tactility of the human body. I will apply the theories of two dimensional pictorial space to ascertain if they are operating in the work of Freud and Auerbach. It will be shown that these theories of pictorial space are intuitively understood by these artists in construction of the illusion of three dimensional space on a two dimensional picture plane. However, the theories of two dimensional pictorial space are also challenged by these artists at the same time they are being used.

The next question to answer relates to techniques which merge oil painting with three dimensional computer generated environments. Char Davies, a multimedia artist, will be examined as a case study. I will be drawing on her essay "Virtual Space" (2004) and Laurie McRobert's book, *Char Davies' Immersive Virtual Art and the Essence of Spatiality* (2007). Her work may help in understanding how to merge oil painting with three dimensional computer generated immersive virtual space. She has a background as a painter, and incorporates the natural landscape into real-time three dimensional virtual environments. She attempts to animate the brushstroke in virtual space. Davies presents a challenge to the linear and geometric depiction of two dimensional and three dimensional space. She does

this by dissolving boundaries between objects and the space around the objects, using transparent digital images.

Finally, I will examine how to construct a multimedia installation, utilising the portraits and three dimensional animations in which the viewer will have a semi immersive experience. To understand how to build a multimedia installation there will be a discussion of mixed reality environments as defined by Fumio Kishino and Paul Milgram in their essay, "A Taxonomy of Mixed Reality Visual Displays" (1994). They define mixed reality as one "that involves the merging of real and virtual worlds".[1] This will form the framework for constructing "CAVE Painting" which will involve real and virtual objects within a real space. As well, to achieve the effect of immersing the viewers in the installation, I will be drawing on Laurie McRoberts' definition of a CAVE (Cave audio-visual environment) in his text, *Char Davies' Immersive Virtual Art and the Essence of Spatiality* (2007). This CAVE environment uses a cube which has virtual images projected onto it via a computer. The user enters this cube and is surrounded by the virtual imagery leading to a sense of semi immersion.

1.3 Methodology

1.3.1 Construction of two and three dimensional pictorial space

This chapter will examine theories of Renaissance perspective and three dimensional computer generated space. To understand Renaissance perspective I will look at Euclid's theorem of parallel lines, Leon Battista Alberti's rules of perspective in his book *Della Pittura* (tran:1966), and Erwin Panofsky's critical analysis of Renaissance perspective in his book *Perspective as Symbolic Form* (1991). To understand three dimensional computer generated space I will explain Rene Descartes' Cartesian coordinate system, and discuss Lev Manovich's theories on three dimensional space in his book *The Language of the New Media* (2001). We may observe that Renaissance perspective has directly influenced the construction of three dimensional computer generated pictorial space. Both Renaissance perspective and the Cartesian coordinate system are used to represent the illusion of three dimensional space based on mathematical and geometric rules or systems. Two dimensional space is described on a flat picture plane using Renaissance perspective, such as a canvas. Three dimensional space is described on a computer screen that uses Renaissance perspective and the Cartesian coordinate system.

To begin the discussion of the link between two and three dimensional pictorial space it is important to look at Euclid's theory of vision. Euclid, a 300 BC Greek Mathematician,

[1] Kishino and Milgram, *A Taxonomy of Mixed Reality Visual Displays*,1994, p.3

developed Euclidian geometric theory. He stated that a bundle of visual rays issues from the eye and strikes the object that it is looking at. The eyes see in straight lines, and touch the object they are looking upon at one point.[2] This bundle of rays is finite and dense in the middle, thinning out at the edge.[3] Thus we see only certain points of an object but not the whole object. Euclid also believed that the eyes vibrate the visual rays quickly so that each one sweeps out a little area and we see the whole object.[4] An object located nearby is seen more clearly than an object of equal size located at a distance.[5] Every object has a certain limit of distance beyond which it cannot be seen.[6] Objects of equal size and unequally distant appear unequal, and the one lying nearer to the eye always appears larger.[7] Parallel lines, when seen from a distance appear not to be equally distant from each other.[8] These theories form a basis for perspective that occurred in the Renaissance era.

In 1435, Leon Battisa Alberti, a Renaissance architect and painter, wrote *Della Pittura* (tran:1966) outlining the rules of perspective.[9] In his development of these rules he drew on Euclid's geometric theory that states that the visual rays emanating from the eye are straight lines, and that these straight lines converge at a vanishing point as they recede into the distance. He described a visual pyramid that fans out from the eye creating a "quadrangle of right angles". [10] He stated that this quadrangle was an "open window through which I see what I want to paint".[11] He drew a cross section on the visual pyramid where the line of sight from the eye hit the quadrangle or picture plane. On this cross section, or horizon line, he established a vanishing point where all parallel lines receded into infinite space. Horizontal lines that intersect these parallel lines became smaller proportionally as they got closer to the vanishing point. These horizontal lines were ascertained by looking at where these lines in the real world intersected the picture plane, as with a tiled pavement. All objects placed within all these lines got smaller as they receded into the picture plane, creating the illusion of three dimensional pictorial space.

Erwin Panofsky, in his text, *Perspective as Symbolic Form* (tran:1991), examines Alberti's perspective rules used in constructing two dimensional pictorial space. Panofsky defines perspective as the meeting of perpendiculars at a vanishing point:

> *First, all perpendiculars meet at vanishing point, which is determined by the perpendicular drawn from the eye to the picture plane. Second, all parallels, in*

[2] Park, David. *The Fire within the Eye*. 1997 p.55
[3] Ibid, p.55
[4] Ibid, p.55
[5] Ibid, p.57
[6] Ibid, p.57
[7] Ibid, p. 57
[8] Ibid, p.57
[9] Ibid, p. 127
[10] Alberti, Leon Battista. *Della Pittura*. Trans:1966 p. 56
[11] Ibid, p.56

whatever direction they lie, have a common vanishing point. If they lie in a horizontal plane, then their vanishing point lies always on the horizon, that is, on the horizontal line through the vanishing point. If they form a 45-degree angle with the picture plane, then the distance between their vanishing point and the central vanishing point is equal to the distance between the eye and the picture plane. Third, equal dimensions diminish progressively as they recede in space, so that any proportion of the picture – assuming the location of the eye is known – is calculable from the preceding portion.[12]

Panofsky argues that this perspective based system is based on mathematical principles and the concept of infinite space, has influenced how artists' depict the natural world. He argues that this system has led to a rigid and geometrical depiction of two dimensional pictorial space. He criticises this perspectival method believing we perceive space in a spherical and non - linear way, based on physiological and psychological processes of the body. According to Panofsky, parallel lines are actually seen as curved as they hit the curved surface on the retina of the eye. Our brains process visual images in a non linear way, and we perceive space as discontinuous. Our senses do not provide us with an infinite awareness of space.

The rules of perspective, when combined with Rene Descartes' Cartesian coordinate system, have led to the development of three dimensional computer generated pictorial space. Rene Descartes was a French mathematician, physicist and philosopher (1596 –1650), and his coordinate system is a way of representing three dimensional space that has three axes X, Y and Z. These three axes are defined in terms of three planes. The three axes have both a positive and negative direction. The X and Y axes are perpendicular to the picture plane, and the Z axis represents depth and comes out of and recedes into the picture plane. A point in space has three values (X, Y, Z) that is plotted on all three axes. There are three numerical numbers that are applied to each point, which locates it in three dimensional space. A three dimensional object is made out a collection of points or vertices, each with an x, y and z numerical value. These points are joined by lines that form a wireframe or skeleton.[13] This system forms the basis of three dimensional computer software, and like Renaissance perspective, is based on mathematical and geometric theory.

Lev Manovich in his text *The Language of the New Media* (2001) stipulates that perspective has led to the development of three dimensional computer generated space. He believes that three dimensional computer generated space is empty Renaissance perspectival space that is based on the Cartesian coordinate system. This three dimensional space comes into being once objects are created by three dimensional modelling and animation software, and these

[12] Panofsky, Erwin. *Perspective as Symbolic Form*. 1991. p. 28
[13] O'Rourke, Michael. *Principles of Three-Dimensional Computer Animation*. 1998. p.28

objects are separate from each other and the space around them. Three dimensional space is defined by the boundaries and distance between those objects in that space. There is no interaction between the objects and the three dimensional virtual space that surrounds these objects. In contrast with Renaissance perspectival space which is systematic and infinite, Manovich believes three dimensional space is more like the aggregate space of the classical antiquity era. By this he means that the objects painted in the classical era before the Renaissance, were given all the attention, with little regard for the space around them.

In conclusion, two dimensional perspective had its beginnings in Euclid's theorem that asserts that parallel lines, when seen from the distance, merge. This premise was further developed by Alberti to give rise to Renaissance perspective that stipulates that these parallel lines recede into a common vanishing point on an imaginary horizon. Objects situated within these lines get smaller proportionally as they get nearer to the horizon line. This perspectival method is used to display the illusion of three dimensional space on a two dimensional picture plane. Three dimensional space is based on Renaissance perspective, and Descartes' Cartesian coordinate system based on x, y and z numerical values. This three dimensional space occurs on a computer screen. Both two and three dimensional pictorial space are based on a mathematical and geometric structure. The following chapter will explore how these theories apply to artists who work with two and three dimensional pictorial space.

1.3.2 Theories of pictorial space in the techniques of figurative painters Frank Auerbach and Lucian Freud, and multimedia artist Char Davies

To investigate methods for the integration of oil painting on canvas with three dimensional computer generated environments, I will begin by discussing the historical theories of two dimensional pictorial space in regard to the work of contemporary figurative painters Frank Auerbach and Lucian Freud. I will then proceed to discuss the historical theories of two and three dimensional space in regard to multimedia artist Char Davies. It will be posited that Auerbach and Freud have an awareness of Renaissance perspective to create the illusion of three dimensional space on a two dimensional picture plane such as a canvas. Both artists do not directly draw the perspective grid on their canvases, and may present a challenge to the use of perspective in their painting. It will be posited that Davies uses techniques and theories developed from her painting, and translates these into her three dimensional virtual worlds. She is working within the paradigm of three dimensional Cartesian space, and uses it to create animated virtual space. At the same time she challenges this geometric ordering of three dimensional space by dissolving boundaries between objects and the space around her objects.

Auerbach and Freud have an awareness of Renaissance perspective to create the illusion of three dimensional space. They do not literally create a perspective framework using drawn lines, but paint directly from life onto the canvas with oil paint. As observed by Robert Hughes, working from the live model allows these artists to represent the body as not fixed or static.[14] Renaissance perspective is a system that is mathematical and geometric, and may force the artist into depicting the figure as static and planar. Auerbach and Freud use a painterly approach to depicting the figure. They build up the surfaces of their canvases into a raised textural surface creating the illusion of three dimensional form. Their brushstrokes represent an intuitive paradigm that challenges a bias based solely on the geometric construction of space. Their illusory forms recede in space, but at the same time they protrude out of the picture plane.

Next, I will be looking at how theories of two and three dimensional pictorial space are evident in the work of multimedia artist Char Davies. I will be looking at her essay on "Virtual Space" (2004) and the book *Char Davies' Immersive Virtual Art and the Essence of Spatiality* (2007) by Laurie McRobert. Davies has a background as a painter, and incorporates the natural landscape into real-time three dimensional virtual environments. Descartes' Cartesian coordinate system, based on x, y and z numerical values, allows Davies' virtual worlds to become time-based. She is attempting to animate the two dimensional brushstroke in three dimensional virtual environments. However, Davies is also challenging the linear and geometric rigidity of computer generated pictorial space. She does this by dissolving the boundaries of her three dimensional forms with the space around these forms. She presents a challenge to Manovich's view of three dimensional pictorial space as being composed of separate objects that bear no relationship to the space around them.

1.3.4 Integrating the theories of two and three dimensional pictorial space, and the techniques of Auerbach, Freud and Davies to the multimedia installation CAVE Painting

To construct CAVE Painting I will utilise theories of two and three dimensional pictorial space as a basis for its construction. I will then use the techniques developed by figurative painters, Frank Auerbach and Lucian Freud, and multimedia artist Char Davies. Having an understanding of how Renaissance perspective is used in depicting the illusion of three dimensional form will aid in the construction of the portrait on canvas. I will be looking at the painterly techniques of Auerbach and Freud, who use oil paint in a textural way to describe illusory three dimensional forms based on the live model. Having an understanding of how three dimensional Cartesian space is used in depicting the image in motion will aid in

[14] Hughes, Robert. *Frank Auerbach*. 1990 p.10

constructing the three dimensional computer environments. I will be looking at Davies' techniques in animating the brushstroke in three dimensional virtual space.

First, I will draw on the theories of two dimensional pictorial space in the construction of my portraits. Using Alberti's Renaissance perspective rules derived from Euclid's theorems, I will paint the human head on a square canvas. However, these parallel lines receding to a vanishing point on the horizon will not be drawn literally on the canvas. I will be aware of how they are used to achieve the illusion of three dimensional pictorial space to inform the portraits. Painting only from life will be my approach to constructing the portrait. The literal use of perspective lines can be limiting in that it can create a geometric look of what is being painted. I want to allow for an organic and intuitive response to the live model, thus the lines of perspective will not be drawn on the canvas but I will be aware of how they are used.

As well, Panofsky's view of depicting two dimensional pictorial space as being a physiological and psychological process will be drawn upon in the construction of the portraits. He criticises perspective as being rigid, because it is based on mathematics and geometrical ordering of space. He believes we perceive space in a non linear and spherical way. This idea will be used in the portrait as there will be no hard edges or straight lines. As well, painting from the live model will be a process of looking at what is being painted in a non linear way. The human head will be observed from many different viewpoints at once. Panofsky's view of Renaissance perspective as being homogenous will be drawn upon in the portrait. The background and the head will be treated as one form to create a sense of unified pictorial space.

I will be painting the portraits from live models, and drawing on Auerbach and Freud's painterly approach to describing the figure. Their use of oil paint involves a gestural technique, and they emphasise its textural qualities. They create a raised textural surface of many layers that protrude from the surface of the canvas. I will also use the textural qualities of the oil paint to produce a raised surface that creates an illusion of a solid, three dimensional form. These artists also employ Renaissance perspective to create the illusion of three dimensional space on a two dimensional picture plane. However, they may not draw the perspective lines onto the surface of the canvas, but they have an awareness of these rules. If they draw onto the surface of the canvas before painting, this is used as a compositional guide in placing the figure or objects correctly. They prefer to paint from the live model that allows for an organic and intuitive depiction of the figure. Their techniques will be useful in challenging a bias based solely on the geometrical construction of space.

Second, I will be drawing on the theories of three dimensional pictorial space to construct the three dimensional immersive environments. I will illustrate Manovich's proposition that

Renaissance perspective has been taken up in the depiction of three dimensional computer generated space, by combining the portraits with three dimensional immersive environments. The portrait will be constructed using perspective as a guiding principle, and will be combined with three dimensional immersive environments that utilise the XYZ coordinates of Cartesian coordinate system.

I will challenge Manovich's assertion that three dimensional space is void and made up of a separate collection of unrelated objects. I will do this by converging the foreground and the background into the one unified form in the three dimensional environments, using transparency. I will use semi transparent three dimensional objects that will show some of the background. This merging of foreground and background will also illustrate Panofsky's idea of a homogenised picture plane, which may be achieved by employing Renaissance perspective methods.

Manovich believes that navigation through three dimensional space is how the user interacts with this space. I will not be adhering to this idea, but will present the three dimensional environments in a fixed position. The user will not be able to interact with my three dimensional environments as it is intended that they be viewed only. This is to maintain a link with two dimensional painting that is viewed in a fixed position on a wall.

I will be looking at the techniques of multimedia artist Char Davies who combines images of nature into three dimensional computer generated environments. She is attempting to animate the brushstroke in virtual three dimensional space, using Descartes' Cartesian coordinate system as her structure. I will be animating the textures of the portraits derived from the live model in virtual three dimensional Cartesian space. She also attempts to dissolve the boundaries between her objects and the space around them to challenge the mathematical and geometric ordering of virtual three dimensional space. She does this by using transparency in her virtual objects that allows the space to be seen through these objects. Again, I will be adopting her approach of adding transparency to my three dimensional objects to challenge this mathematical representation of three dimensional space, but I will also accentuate some of the hard edges. I wish to subvert and utilise this geometric ordering of three dimensional Cartesian space.

I will be semi immersing the user in the CAVE Painting installation. Davies achieves full body immersion in her three dimensional virtual environments by the user by wearing a head mounted display (HMD). It is worn on the user's head, and it displays three dimensional environments on two liquid crystal display screens connected to a computer. Manovich describes navigation through three dimensional space triggering events as they happen in real time, as unique to the medium. CAVE Painting will differ from Davies' work in that the

user will not be able to enter into, and trigger events, in real time. The three dimensional immersive environments in CAVE Painting will remain in a fixed viewpoint. This is to reinforce the connection to painting that is seen from a single viewpoint.

I will use Laurie McRobert's definition of a Cave Audio Visual Environment (CAVE), which is a multi-person ten-foot-cube space where three dimensional virtual images are projected onto the surrounding walls and wall and ceiling. [15] McRobert compares and contrasts a CAVE environment to a Head Mounted Display (HMD) in their ability to achieve a sense of immersion. I will use a CAVE environment in this cube arrangement to allow the imagery of CAVE painting to surround the viewer in three hundred and sixty degrees. This will create a sense of semi immersion, but still be connected to a real physical space. As well, a CAVE environment is built in a real physical space that minimises the feeling of being disembodied which may occur with use of a Head Mounted Display. Using a CAVE environment in CAVE Painting will allow the one or more users to view the work simultaneously. In Davies' work only one user can enter her three dimensional world at a time.

I will build a mixed media installation based on Fumio Kishino and Paul Milgram's definition of mixed reality. They provide theoretical insight into the process of defining media that combines the real world and virtual images simultaneously. They define mixed reality as one that "involves the merging of real and virtual worlds".[16] The portrait will represent the real object, and the three dimensional immersive environments containing the digitised portraits, will represent the virtual object.

1. 4 Rationale

Why is it important to examine the integration of oil painting with three dimensional immersive environments? First, oil painting and three dimensional computer generated environments have not been combined into a single art form to date. Oil painting and three dimensional virtual environments have been treated as separate mediums by artists till now. Even though Davies is attempting to show a painterly approach, she has not used oil paint in her virtual environments.

A painterly, intuitive approach that is achieved with oil paint on canvas is needed in three dimensional computer generated space. Using three dimensional computer technology can often be time-consuming for the artist. Artists have to learn complex computational procedures to create their work in three dimensional computer space, often involving some knowledge in programming. There is a need for them to embrace this new medium with the

[15] McRobert, Laurie. *Char Davies' Immersive Virtual Art and the Essence of Spatiality*. 2007.p.100
[16] Kishino and Milgram, *A Taxonomy of Mixed Reality Visual Displays*,1994, p.2

help of programmers. It would be of benefit if the creation of three dimensional software were driven by artists, allowing for a more intuitive and user friendly experience in digital image making.

Understanding the mathematical and geometric principles, on which two and three dimensional pictorial space is constructed, will allow the artist to challenge these paradigms. Artists have long discovered that Renaissance perspective can prevent an intuitive and organic response to painting. This idea of organic process of image making needs to be adopted in three dimensional space. Thus the depiction of the artist's intuitive brushstroke in three dimensional computer generated environments is important. It is intended that the artist's touch be carried into three dimensional virtual space, challenging the geometric rigidity of virtual space. An artist may not be aware of these mathematical and geometric paradigms, leading to a pictorial space that may be rigid and linear.

A heightened sensation of immersion can be achieved through three dimensional virtual space, that may be harder to achieve with oil painting. To date, oil painting can only be viewed from a fixed viewpoint. Now, real-time three dimensional virtual space allows for multiple viewpoints within the one scene, which was not possible with oil painting. The brushstroke can be animated over time. Oil painting in three dimensional virtual space can be explored in real time, and interaction with the objects in that space can occur. Painting is now possible in real time inside three dimensional virtual environments that can provide a sense of immersion. Immersion in three dimensional space can provide the viewer with a sensation of being inside the painting. Static oil painting has not been able to achieve this heightened sense of immersion.

1.5 Summary

In summary, in this chapter I have provided a description of my project called CAVE Painting. It will be a multimedia installation, combining two and three dimensional pictorial space that will immerse the viewer. I will apply the theories of two and three dimensional space as a guide to construct the installation. The theories of two dimensional pictorial space will involve examining Euclid's theorems of parallel lines, Alberti's Renaissance perspective, and Panofsky's critique of Renaissance perspective. The theories of three dimensional pictorial space will involve examining Descartes' Cartesian coordinate system, and Manovich's critical evaluation of this system. I will explain in chapter two how theories of two dimensional space has led to the development of three dimensional space. This will provide a framework for looking at two and three dimensional practitioners, and how these theories relate to my project which combines the two pictorial space paradigms.

In this chapter I have described practitioners who are working within the paradigms of two and three dimensional space. Auerbach and Freud are figurative painters who work in the two dimensional framework, derived from Renaissance perspective. They use an intuitive and organic approach in depicting the live model. Their approach both challenges and uses the Renaissance perspective paradigm. In chapter three, I will be discussing their techniques further, and how theories of two dimensional pictorial space may or may not influence their work. In chapter four, I will relate their techniques and theories of two dimensional pictorial space to my construction of the portrait.

I have briefly mentioned Char Davies in this chapter, a multimedia artist working within the paradigm of three dimensional pictorial space. She attempts to animate the brushstroke in three dimensional space, using nature as a motif. She challenges the mathematical construction of three dimensional Cartesian space by dissolving boundaries between her objects and the space around her objects. She immerses the user by way of a Head Mounted Display (HMD). The user is able to interact with her objects. I will be looking at how theories of two and three dimensional space may or may not influence her techniques in chapter three. I will be looking at her techniques, and the theories of two and three dimensional space, in relation to the construction of the three dimensional environments in chapter four.

Finally, in this chapter I have mentioned the construction of the multimedia installation combining portraits with three dimensional computer environments called CAVE Painting. I intend to semi immerse the viewer in this installation. I have mentioned McRobert's definition of a CAVE which is a cube with projected virtual images on the walls and floor and ceiling. I will use his definition of a CAVE to construct my project and this will be discussed in chapter four. I will also compare and contrast Davies head mounted display with a CAVE environment in obtaining a sense of immersion. I will be looking a Milgram and Kishino's theoretical discussion on what is meant by mixed reality in chapter four. They define mixed reality as the "merging of the real with the virtual".[17] This will give me understanding in how to combine the painted object with three dimensional virtual environments.

[17] Ibid, p.2

CHAPTER TWO

2. Construction of two and three dimensional pictorial space

2.1 Two dimensional pictorial space

Two dimensional space is a representation of the illusion of three dimensional pictorial space on a flat surface, such as a canvas. During the Renaissance era, which occurred from the fourteenth to the seventeenth century, a system of perspective was developed to achieve this. To understand the Renaissance rules of perspective it is essential to look at Euclid's theory of vision that he described in his book *Optics*. Euclid was a student of one of Plato's students, and around 300 B.C. he postulated his theories of a "mathematical theory of vision".[18] He declared that the eyes see in straight lines and touch the object looked upon at one point.[19] This bundle of rays is finite, dense in the middle and thinning out at the edge.[20] Thus he asserted that we see only certain points of an object, but not the whole object. Euclid stated that the eyes vibrate the visual rays quickly, so that each one sweeps out a little area and we see the whole object.[21] An object located nearby is seen more clearly than an object of equal size located at a distance.[22] Every object has a certain limit of distance beyond which it cannot be seen.[23] Objects of equal size and unequally distant appear unequal, and the one lying nearer to the eye always appears larger.[24] Parallel lines, when seen from a distance, appear not to be equally distant from each other.[25] Essentially, it is his idea of parallel lines converging that provided the seed for the development of perspective in the Renaissance during the 1400's.

An illusion of three dimensional space on the canvas, or linen support, can be realised by the use of Renaissance perspective developed by Leon Battista Alberti in 1436. Renaissance perspective is based on Euclid's theory that states that parallel lines merge at a vanishing point as they recede into the distance on a two dimensional picture plane. Renaissance perspective applies this theorem by establishing a horizon line with a vanishing point. All horizontal and vertical lines recede proportionally into the vanishing point. Objects decrease in size as they get nearer to the vanishing point.

[18] Park, David. *The Fire within the Eye*. 1997 p.53
[19] Ibid, p.55
[20] Ibid, p.55
[21] Ibid, p.55
[22] Ibid, p.57
[23] Ibid, p.57
[24] Ibid, p. 57
[25] Ibid, p.57

Alberti in his text *Della Pittura* (tran:1966) discusses perspective and the idea of a window through which the "subject is seen," and parallel lines that converge at a vanishing point.[26] His system attempts to represent the illusion of three dimensional space on a two dimensional picture plane. He proposes that we see using a "visual pyramid".[27] This pyramid is made up of Euclid's visual rays, and these rays are more concentrated in the middle, and become less dense at the edges of the pyramid. These visual rays emanate from the eye in straight lines. He states that the base of the triangle is an "open window through which I see what I want to paint".[28] He arbitrarily determines a size of the figure he wanted to depict in this "open window," and divides this figure proportionally in three. This measurement is called "braccio".[29]

He uses this measurement to divide up the base of the picture plane. The base of this picture plane directly corresponds to the nearest horizontal line of the pavement viewed in reality. Within the picture plane he establishes where the central ray from his eye hits the picture plane, which he calls the "centric point".[30] This point is the vanishing point, and is where the horizontal horizon line sits. The figure to be depicted will always have its head touching this line and no higher, so it sits on the same plane as the objects to be painted.

From the base of the picture plane, which has been proportionally divided up, are drawn straight lines to the centric or vanishing point. This vanishing point illustrates Euclid's theorem of parallel lines that merge at a central point when seen from a distance. These lines extend into infinite space, and he claims "demonstrate to me how much each transverse quantity is altered visually".[31] Alberti proceeded to draw a horizontal line parallel to the base of the picture plane. The distance between the base of the picture plane and the added horizontal line would be divided into three parts. Then, moving towards the horizon line, he creates a distance equal to two of the three parts and divides this in three again, until the distances between the parts become smaller. All objects and figures to be painted are situated in these lines recede proportionally as they get closer to the horizon line.

Erwin Panofsky, in his text *Perspective as Symbolic Form* (trans:1966), critically examines Alberti's Renaissance perspective, and gives us insight into how it has influenced the depiction of space. Panofsky defines perspective "as a planar cross section through the so-called visual pyramid; the apex of this pyramid is the eye, which is then connected with individual points within the space to be represented".[32] Panofsky also states that Renaissance

[26] Alberti, Leon Battista. *Della Pittura*. tran:1966 p.127
[27] Ibid, p.47
[28] Ibid, p.56
[29] Ibid, p.56
[30] Ibid, p.56
[31] Ibid, p. 56
[32] Panofsky, Erwin. *Perspective as Symbolic Form*. (trans:1991) p. 28

perspective draws on Euclid's theories of optics that assert that parallel lines, when seen from a distance, appear not to be equally distant from each other.[33] In other words, as the parallel lines extend away from the viewer they appear to converge. These parallel lines extend into infinite space. Thus, objects to be represented within the picture plane become smaller as they recede into space until they eventually disappear, creating the illusion of three dimensional space.

Panofsky explains the ideas of Renaissance perspective, and claims that certain laws should be abided by to construct a picture, and "first, all perpendiculars meet at vanishing point, which is determined by the perpendicular drawn from the eye to the picture plane".[34] There is a rectangle through which the scene is visualised, and a vanishing point is established where the line of sight from the eye hits this rectangle. "Second, all parallels, in whatever direction they lie, have a common vanishing point."[35] This vanishing point sits on a horizon line, drawn horizontally on the rectangle, where all the parallel lines in the scene will converge. Panofsky points out that with parallel lines "if they lie in a horizontal plane, then their vanishing point lies always on the horizon, that is, on the horizontal line through the vanishing point", and "If they form a 45-degree angle with the picture plane, then the distance between their vanishing point and the central vanishing point is equal to the distance between the eye and the picture plane".[36] Thus the distance between the person viewing the scene and the rectangle, can be exactly calculated, depending on the angles of the parallel lines receding into the vanishing point. Third, equal dimensions diminish progressively as they recede in space, so that any proportion of the picture – assuming the location of the eye is known – is calculable from the preceding portion".[37] This means that the distance between objects within the scene can be precisely measured, such as with checkerboard floor tiles that are common in Renaissance paintings.

Panofsky argues that this mathematical depiction of space is limiting, as it makes several assumptions "that we see with a single and immobile eye" and "that the planar cross section of the visual pyramid can pass for an adequate reproduction of our optical image".[38] In reality, we see with "two eyes that are constantly moving, resulting in a spheroidal field of vision".[39] He believes our consciousness generalises any distortions of an object and we perceive space as being non linear. He also believes that a projection of an object onto the retina of the eye is concave, and not flat, leading to a slightly curved appearance of an object.

[33] Park, David. *The Fire within the Eye*. 1997 p.57
[34] Panofsky, Erwin. *Perspective as Symbolic Form*. (Trans:1991). p. 28
[35] Ibid, p.28
[36] Ibid, p.28
[37] Ibid. p.28
[38] Ibid. p.29
[39] Ibid. p.31

Panofsky argues that perspectival space is a human construct, and although derived from reality, it is an aberration. In reality, our two eyes form a separate single image in two dimensions, which are then both merged to give us a sense of three dimensional construction of what we are looking at. As well, this image is reversed from left to right, or right to left, and projected smaller, upside down on our retina. The retina is a curved surface, so strong horizontals and verticals appear slightly curved. This image is sent to our brain from photo-receptors making up the retina, via the optic nerve. Thus Panofsky is referring to the psycho-physiological science of optics to contradict linear perspective, and its reliance on a mathematical and systematic way of representing reality.

Panofsky's central premise is that Renaissance perspective has "greatly influenced perception".[40] It is symbolic of a scientific mode of representing space. Thus, objects became discrete, proportional entities situated within by the tight converging lines of linear perspective. Panofsky proposes that Medieval artists lacked these rules of perspective, and their paintings looked irregular, not in proportion, and flat.[41] The Renaissance era spawned new ideas of representing reality; it used a scientific methodology and a mathematical ordering and depiction of infinite space that was championed by linear perspective. Grootenboer points out that Panofsky believed that the discovery of the vanishing point was the symbol for infinity, and "infinity excludes everything that concerns the point of view, namely, a well-defined location in the centre of a comprehensible space", and "at the same time, it includes everything that is beyond view, placement, or even measurement".[42] Thus objects located within the picture plane grow smaller and smaller as they recede into space, until eventually they disappear. The existence of objects and space beyond the horizon line is implied. In reality our perceptions do not allow us to perceive space as infinite, thus perspective is based on a theoretical construct of space. Both Panofsky and Grootenboer agree that linear perspective has influenced how images are constructed on a two dimensional surface, and this has influenced how artists may depict reality.

It has been shown how Euclid's theory of parallel lines that merge at a vanishing point was adopted by Alberti in the development of rules of perspective. Alberti's perspective uses this vanishing point where all the parallel lines recede into infinite space. Figures and objects placed within these guidelines recede as they get closer to the horizon line. This system is based on straight lines that represent visual rays emanating from the eye. Panofsky informs us that this system is mathematical, and may not be how we perceive reality. He believes that we perceive space in a non linear way, and our senses do not know how to comprehend infinite space. Two dimensional pictorial space has been discussed, and now I will proceed to

[40] Grootenboer, Hanneke. *The Rhetoric of Perspective. Realism and Illusionism in Seventeenth-Century Dutch Still-Life Painting*. 2005. p.114
[41] Ibid, p.114
[42] Ibid, p.117

examine how perspective has been adopted in depicting three dimensional computer generated space.

2.2 Three dimensional pictorial space

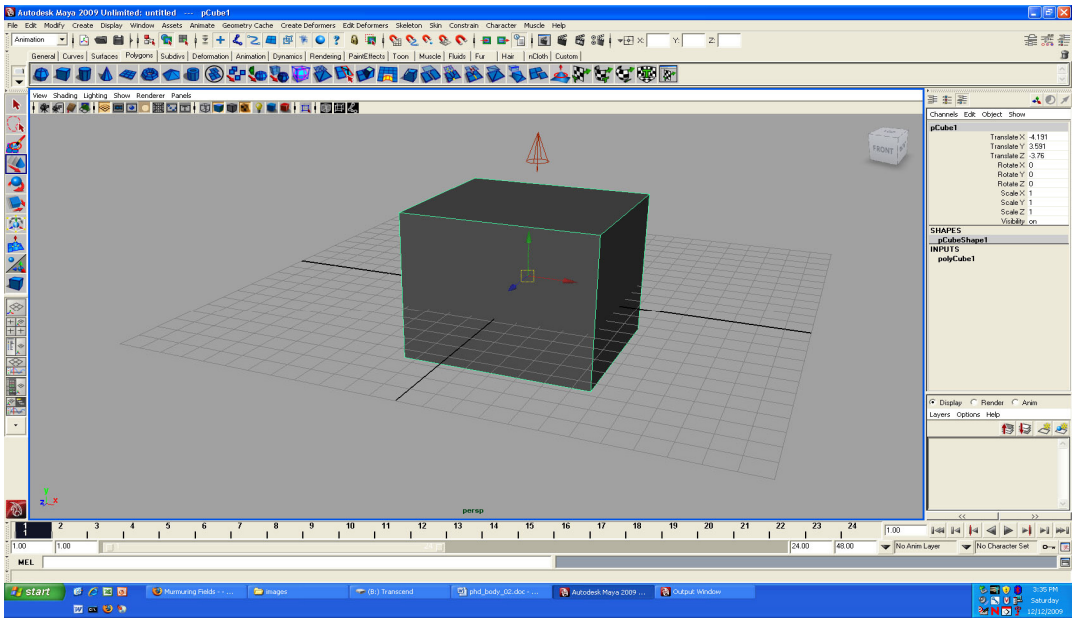
Three dimensional computer generated space uses the Renaissance perspective model in the construction of its space. Euclidian geometric theory and Cartesian space have also been used. Cartesian space is represented on a computer screen, and it depicts the illusion of three dimensional pictorial space. The Cartesian coordinate has developed from Euclid's geometric theory and Renaissance perspective which state that as parallel lines recede in space they converge at a common vanishing point but never meet. This Cartesian coordinate system was developed by Rene Descartes, a 17th century philosopher and mathematician, and it uses the XYZ coordinate system to extend two dimensional perspectival space into three dimensional pictorial space.[43]

To understand the Cartesian coordinate system developed by Descartes, it is important to define the geometric construction of three dimensional pictorial space. Alberti in *Della Pittura* (trans:1966) expands on Euclid's definitions of how geometric space is constructed by providing definitions of a point, line, plane and polygon. He defines a point as "a figure which cannot be divided into parts".[44] A line is a succession of points in a row, "whose length can be divided but whose width is so fine it cannot be split".[45] He defines a plane as "more lines, like threads woven together in a cloth, make a plane".[46] He defines a polygon as a plane whose outline can change in number, length and the angles in between the outlines can change as well, to make a triangle or quadrangle.[47] These basic geometric elements make up the foundations of three dimensional Cartesian space.

Using these geometric principles, the Cartesian coordinate system locates points in space that are connected by lines to form triangles that make up a three dimensional object. This forms the structure of three dimensional modelling and animation software. The picture below is a cube situated in three dimensional computer generated space. The grid gives the viewer a frame of reference when creating or viewing objects. The origin is at the centre of this space where the gridlines converge. This three dimensional space has length, width and depth, as represented by the X, Y and Z axes. The letter X is width, Y is height and Z is depth. Each axis can be divided into units of measurement. The three axes have both a positive and

[43] O'Rourke, Michael. *Principles of Three-Dimensional Computer Animation*. 1998. p.30
[44] Alberti, Leon Battista. *Della Pittura*. (trans:1966) p. 43
[45] Ibid, p.43
[46] Ibid, p.44
[47] Ibid, p.44

negative direction. A point in space has three units of measurement based on the XYZ axis. There are three numerical numbers that are applied to each point, which locates it in three dimensional space. A three dimensional object is made out a collection of points or vertices, each with an x, y and z numerical value. These vertices are joined by lines to create two dimensional triangles. These two dimensional triangles make up the surface of the three dimensional object. These triangles are connected to each other to form a wireframe or skeleton. The computer then adds a surface to the object, creating the illusion of it being solid. The cube below is located at 0,0,0 units and has a scale of 4,4,4 units.



2.1 Image of a wireframe of a cube in a three dimensional modelling and animation software package.

Essentially, the basic unit of virtual three dimensional pictorial space is a point or vertex which is zero dimensional.[48] Two points connected to each other by a straight line is one dimensional (length).[49] A plane consists of a one dimensional line that is extended in "any one direction" to create a flat surface, and "continues infinitely in two directions".[50] It is two dimensional, thus having width and length. A polygon is a flat surface that has three points in space that are connected by lines to create a two dimensional triangle.[51] They are the basic element of virtual space, joined to each to construct the shape of the three dimensional object. These triangles making up the object are positioned at different angles in space to give the illusion of three dimensions. A three dimensional wireframe is made up of polygons that make up the shape of the three dimensional object, also called a mesh, which can be thought of as the skeleton of the three dimensional object. It has length, width and height. The

[48] O'Rourke, Michael. *Principles of Three-Dimensional Computer Animation*. 1998. p.15
[49] Ibid, p.15
[50] Ibid, p.15
[51] Ibid, p.16

greater the number of polygons that make up the virtual three dimensional object, the greater the level of detail it has. Organic looking objects with curvature of their surface can be achieved by this method of increasing the number of polygons. However, O'Rourke stipulates that the surface of a virtual three dimensional object "never yields a truly curved surface", even if the number of polygons is increased.[52] This can lead to virtual three dimensional objects looking geometrical and symmetrical.

The next step in building the virtual three dimensional object requires the creation of a surface. The computer assigns a surface by "applying mathematical formulae that convert model information about the surface orientations and reflectivities into pixel values".[53] A light source is created within a virtual three dimensional scene to illuminate the surface of the object creating a sense of pictorial depth. Lambert shading is a common method of simulating light falling on an object that "states that the intensity of the light reflected from a plane surface is related to the angle of incidence of the arriving light".[54] This provides a consistent light and "clarifies angular relationships between surfaces and enhances the illusion of pictorial depth by apparently placing surfaces at various angles to the picture plane".[55]

Simulating the appearance of a surface also involves using a two dimensional digital texture. This digital texture covers the wireframe of the three dimensional object. This texture is a two dimensional image that creates the illusion of a three dimensional surface. It is usually created in a two dimensional image manipulation program such as Photoshop. This technique maps the two dimensional image with the vertices of the wireframe on the three dimensional object. Surface characteristics of an object can be manipulated by "linking the brightness or colour of a pixel in the image map to the characteristics of a point in the surface where that pixel is mapped".[56] As a result the pixels in the texture map can simulate transparency, reflectivity and the roughness or smoothness of the surface.

This cube above can be viewed from any angle using the three dimensional software. In both the Cartesian coordinate system and Renaissance perspective, space is mathematically reconstructed in a precise and geometric way. The space around the objects may be seen as as void until an object is created, thus the objects themselves define the space around them. We can view an object from any angle using this three dimensional software. Gone is the fixed viewpoint of the observer. Any object can be scrutinized from any angle, much akin to picking up an apple and studying its shape and colour in reality. We can zoom up and have a microscopic perusal of an object, or zoom out into the distance and the object disappears into infinite void. We can also enter an object and see its internal structure. Large distances and

[52] Ibid, p.17
[53] Mitchell, William. *The Reconfigured Eye. Visual Truth in the Post-Photographic Era*. 2001. p.137
[54] Ibid, p.140
[55] Ibid, p.141
[56] Kerlow, V. Isaac. *The Art of 3-D Computer Animation and Imaging*. 1996 p.166

microscopic distances can be combined in the one scene by moving the camera viewpoint. The multiplicity of viewpoints can be represented in one scene. In three dimensional computer games, constructed using three dimensional animation and modelling software, users can teleport from one area of the game to another. Physical restraints in the real world no longer hold sway over the user in a three dimensional game environment. With the geometric foundation of three dimensional space explained, I will proceed to look at how Manovich critically evaluates this space.

Lev Manovich, in *The Language of the New Media* (2001), proposes that "virtual spaces are most often not true spaces but collections of separate objects".[57] Three dimensional space without objects may be treated as a void, and when subsequent objects are added they form a reference point to the other existing objects. Thus three dimensional space comes into being in relation to the objects created, and the space in between these objects is the void. Panofsky echoes this idea of the void in looking at two dimensional pictorial space. He states that "the ultimate basis of geometric space is that all its elements, the points which are joined in it, are mere determinants of position, possessing no independent content of their own outside of this relation, this position which they occupy in relation to each other".[58] Panofsky proposes that construction of perspectival space was to create a depiction of infinity and uniformity that our senses cannot provide.[59] Grootenboer, in *The Rhetoric of Perspective* (2005), picks up this idea of the void outlined by Panofsky by claiming that the vanishing point is a nonspatial entity:

> *The central point around which perpsectival space evolves, the vanishing point is itself nonspatial, lacking as it does all qualities of space. Not representing a specific spatial location - given it is a mere point - the vanishing point is at the very heart of pictorial space, while simultaneously falling outside this space. Albeit a central point of spatial illusion in painting, the vanishing point represents the infinite as a finite entity within space.* [60]

This geometric system of representing two dimensional space as a void consisting of separate objects has infiltrated three dimensional space.

Manovich postulates that three dimensional computer space is derived from Panofsky's view of Renaissance perspective as a systematic and mathematically precise space.[61] As discussed previously, the artist begins with an empty space, with a two dimensional

[57] Manovich, Lev. *The Language of the New Media* 2001 p. 253
[58] Panofsky, Erwin. *Perspective as Symbolic Form*. (Trans:1991). p. 30
[59] Ibid, p31
[60] Grootenboer, Hanneke. *The Rhetoric of Perspective. Realism and Illusionism in Seventeenth-Century Dutch Still-Life Painting*. 2005. p.89
[61] Manovich, Lev. *The Language of the New Media* 2001 p. 254

perspective grid that locates objects once they are created. This space is void until polygon objects are created, and these objects are self contained entities bearing no relationship with the space around them. Manovich points out that what is "missing from computer space is space in the sense of medium - an environment in which objects are embedded".[62] He means that what is missing from three dimensional computer generated space is a unity of the object to the background. He is proposing that the objects in this three dimensional space do not interact with the space around them. The space around these objects is not an object in itself, and is empty of content.

In the classical antiquity era before the Renaissance, depicting space biased singular objects.[63] This idea of singular objects has merged with the Renaissance depiction of space as a linear grid, to produce three dimensional computer generated space.[64] In classical antiquity "objects were not merged in a painterly fashion into spatial unity, but rather were affixed to each other in a kind of tectonic or plastic cluster".[65] In other words perspective space had not been conceived yet, and objects were not treated as separate from the space around them afforded to them by the perspective grid. Thus this approach to rendering objects led to a "clumped" depiction of space. According to Manovich, the object had prime importance in the art of antiquity and space between the objects was secondary. Therefore this led to a lack of depth as seen in paintings using Renaissance perspective which was to come later.

It is clear how perspective, using a geometric and linear ordering of space, has been utilised in three dimensional computer generated space. This perspectival system has been updated by adding Descartes' Cartesian coordinate system. The Cartesian coordinate system uses XYZ coordinates in creating illusory three dimensional pictorial space, and is represented on a computer screen. Thus three dimensional objects have length, width and depth. Manovich claims that three dimensional space is void until objects are created. This void visually appears empty on the computer screen, and the Cartesian coordinate system is the invisible structure of this space. These three dimensional objects bear no relationship to the space around them. I will proceed to discuss how the user navigates this three dimensional space. What makes three dimensional space different from Renaissance perspective is that it can be explored by the user over time, and viewed from multiple perspectives.

How do we navigate this three dimensional pictorial space? Manovich asserts that navigation through three dimensional pictorial space is the predominant way of interacting with this

[62] Ibid, p255
[63] Ibid, p257
[64] Ibid, p254
[65] Ibid, p.41

space.[66] He believes that as the user moves through this three dimensional space, a narrative is formed. He maintains that movement through this space is intimately connected to the time it takes to reach its conclusion. In three dimensional computer games the player moves between levels or worlds. This movement is usually based on human real life dynamics; however the user is able to teleport to different areas or levels in the one game. Teleportation involves the user dematerialising from one level in the game, and materialising into another. This is usually instantaneous. Time and space structures are not linear, and real-world boundaries can be transcended.

Manovich proposes that real-time three dimensional games, such as Unreal software that will be used in CAVE Painting, allow for a more interactive pictorial space.[67] Real-time interaction involves the user moving through three dimensional space, and triggering events. With non-interactive three dimensional key frame animation, the movement is pre-rendered by the computer as two dimensional images, and these two dimensional images are complied in a movie editing program and played back one after the other, to give the impression of movement. This is output as one movie file and not subject to interaction. The Unreal game engine is three dimensional computer software which allows the user to explore the game in real-time. The images in the three dimensional game are not pre-rendered. An example of real-time interaction is when the user, via the mouse and keyboard, touches an object, which executes a script or computer code embedded in the object. This action produces a real-time event, such as a door opening.

To illustrate Manovich's ideas about real-time interaction, I will discuss the Unreal game engine which will be used to construct the three dimensional immersive environments in CAVE Painting. The Unreal game environment is three dimensional computer generated space that is a void space until objects are added. To populate the Unreal environment with objects that will be interactive, three dimensional modelling software is used such as Maya. Three dimensional objects are created within Maya. These three dimensional objects are then imported into Unreal. Two dimensional textures are applied to these three dimensional objects in Unreal, to give the illusion of a surface. These two dimensional textures are made in two dimensional image manipulation software such as Photoshop. There is an integration of two dimensional images, and three dimensional space, to give the illusion of three dimensional pictorial space. Interaction is pivotal to navigating this space. The three dimensional objects, once inside Unreal, are able to be interacted with by embedding a script or code into them. As the user touches an object via the mouse, it triggers an event in real-time. The users explore different levels or places, triggering events as they go.

[66] Ibid, p.245
[67] Ibid, p257

Within the Unreal environment there are discrete spaces or levels for the users to visit, and they are linked to each other. When the user starts the game, they instantaneously materialise into the three dimensional pictorial space taking the perspective of the camera. However these spaces may not be adjacent to each other and the user can teleport from one level to the next, as they pass through each stage. Teleporting involves the user being transported from one area of the Unreal environment to another in an instant. Manovich points out that the three dimensional pictorial space "cannot be thought of as a coherent totality", and is a "collection of numerous files, hyperlinked without any overall perspective to them".[68] This differs from Panofsky's Renaissance space that is homogenous, and all the objects are located within one systematic picture plane. The way computers are structured leads to discrete and separate three dimensional spaces that are inter-connected.

2.3 Summary

In summary, it has been my intention to illustrate the evolution of our ability to depict illusory three dimensional pictorial space. It began with Euclid's theorems of parallel lines converging at a vanishing point, which gave rise to Alberti's Renaissance perspective. Alberti's Renaissance pictorial space is based on mathematical and geometric principles creating the illusion of three dimensional space on a two dimensional picture plane. Perspective rules are based on a horizon line, and all perpendicular lines recede into a vanishing point on the horizon line. Objects and figures placed within these guidelines get smaller as they recede in space, creating the illusion of three dimensional space. However, Panofsky asserts that this geometric ordering of space is not how we actually perceive reality. He maintains that we view space in a non linear way, based on physiological and psychological processes of the body.

Rene Descartes' Cartesian coordinate system extends the Renaissance perspectival space into three dimensional computer generated pictorial space. The Cartesian coordinate system represents objects that are composed of x, y and z coordinates, thus allowing objects to have width, depth and length. Three dimensional objects are created using three dimensional computer software. Manovich states that three dimensional pictorial space is void until objects are added, and these objects do not influence the space around them. He suggests that three dimensional space borrows from the art of the classics which biased the depiction of singular objects. This is coupled with the empty Renaissance grid gives rise to three dimensional computer generated space.[69] Manovich states that the user can navigate through this space, triggering events that occur over time. The fixed viewpoint of perspective is no longer fixed in three dimensional computer generated pictorial space.

[68] Ibid, p.257
[69] Ibid, p.254

In the next chapter I will examine how these theories of perspective and three dimensional computer generated space are evident or not in the work of figurative painters Frank Auerbach and Lucian Freud, and multimedia artist Char Davies. Auerbach and Freud are painters working using two dimensional pictorial space. Char Davies has a background as a painter but works with three dimensional pictorial space in her immersive virtual environments. All these artists use geometric systems in depicting space, yet subvert it at the same time. It will be useful to my project to analyse their processes.

CHAPTER THREE

3. Theories of pictorial space in the techniques of figurative painters Frank Auerbach and Lucian Freud, and multimedia artist Char Davies

3.1 How do Auerbach and Freud utilise and challenge theories of two dimensional space in their paintings?

Both Auerbach and Freud are working within the tradition of Alberti's Renaissance perspective. They create the illusion of three dimensional pictorial space on a two dimensional canvas, drawing on Euclid's theorem of parallel lines converging, and Renaissance perspective rules that stipulate that all perpendicular lines meet at a single vanishing point. Their figures and objects get smaller as they recede into space creating a sense of depth. Both artists use a gestural and intuitive approach to applying oil paint to canvas, and work from the live model. They build up many layers of oil paint to produce solid illusory three dimensional forms.

Freud draws on the tradition of Renaissance perspective to create a heightened sense of depth in his paintings. He tends to start with a charcoal drawing as a guide, and begins painting the face and body of his subject, then moves outwards to the edges of the canvas. Depth is created by the perpendicular angles in his paintings meeting at an invisible vanishing point. He may ascertain these perpendicular lines by observing these lines in nature. The straight edges of the floor and ceiling in his interiors recede deeply into his pictorial space. Direct observation allows him this insight, as well as having an awareness of the rules of perspective. His figures and objects in his interiors recede into his illusory three dimensional space. Freud wants to accentuate the three dimensional nature of our reality.

Freud's paintings are process driven. The act of painting itself is where he discovers the subtle variations in tone that describe his illusory three dimensional forms. Capturing the form of the figure requires many hours of observation from life. He paints his figures over a considerable period of time, and often over many years.[70] He is discovering the form of the figure with his acute observational skills as he paints. His figurative forms are not static, but alive and palpable. There is a sense in his work that he has not locked in a predetermined composition, and this is open to change. This process of looking, and then describing what the artist sees at that moment in time, is an organic process. It allows for constant change and re-evaluation.

[70] Hughes, Robert. *Lucian Freud, Paintings*. 1988. p.20

Freud's figures, and the space around the figures, are unified into a whole, illustrating the homogenous space of the Renaissance as highlighted by Panofsky. Freud pays equal attention to the details of the figure and the background, to create this effect of homogenised space. As well, Freud does not bias the figure for the background, and according to Hughes, "he has seen everything with such evenness" that gives his paintings their intensity.[71] The same weight of detail is given to a crack in the wall behind the subject's head, as to the subject's body. This device is what gives Freud's paintings their tension, according to Hughes. Freud does not discriminate between animate and inanimate, and the background is just as much part of the picture as the subject in the foreground. This leads to a unified pictorial space.

Freud subverts the rules of Renaissance perspective by curving the planes or lines that recede into the picture plane, thus illustrating Panofsky's view of the depiction of real space as being curvilinear and spherical. Panofsky's "psycho-physiological" way of perceiving reality proposes we perceive space by our senses in a non-linear way, and this is filtered through our senses and processed by the brain.[72] Panofsky maintains that the lines of the perspective grid are viewed as slightly curved as the image hits the concave retina of the eye. As well, Freud exaggerates the angles of the floor to create a discontinuous pictorial space. In reality, the angles of the floor would not recede in that way. He may be reinforcing the notion that the painting is an artificial construct and does not conform to a mathematical system, as seen in Renaissance perspective pictorial construction. Freud alters the receding lines in his paintings, such as the floorboards, so that they do not all recede correctly to the vanishing point. Freud does this also to accentuate the drama of his paintings, making viewers feel as though they are thrown into his pictorial space.

Freud's technique is to create a heightened sense of illusory three dimensional space on a two dimensional canvas, based on Renaissance perspective, and it attempts to immerse the viewer in two dimensional pictorial space. Freud works on a large scale, thus attempting to elicit a sensation of immersion. Yet unlike Manovich's view of three dimensional pictorial space as being empty until objects are created, Freud's illusorily three dimensional space is integrated. His figures and background coexist, with equal attention given to each. He builds up the forms of his figures using many layers of oil paint directly from the tube. He uses a wet on wet technique, layering wet oil paint over wet oil paint, moulding his forms to create a raised surface. This produces a sculptural effect, and his figures appear three dimensional. He creates a receding pictorial space, and combines this with a raised surface. This allows his figures jump out of the picture plane, and at the same time sit within the depth of the background.

[71] Ibid p.7
[72] Panofsky, Erwin. *Perspective as Symbolic Form*. (Trans:1991). p. 30

Auerbach, like Freud, provides the illusion of three dimensional space on a two dimensional surface, drawing on Renaissance perspective. Again figures and objects in his paintings recede into a vanishing point, to create a sense of depth. Auerbach uses the angles of the room in reality to depict this sense of receding space, and may draw on the rules of perspective to guide him. Auerbach may not always begin with a sketch, but paints directly onto the surface of the canvas. He does not want to be locked into a formula when painting the figure. Again, perspective if used literally can lock in the composition of the painting leading to a less intuitive and organic painting. He uses his understanding of the rules of perspective as a guide to achieving depth in his paintings, and the perspective grid is not actually drawn on the surface of the canvas.

Auerbach paints from the live model, allowing him to depict the human form in a state of flux. He is not bound by convention or rules of representing two dimensional pictorial space, as seen in Renaissance perspective. Hughes describes Auerbach's attachment to painting from life as his way of describing 'newness'. He explains "newness" as "vitality, the seizure of something real from the world and its coding – however imperfect and approximate – in paint".[73] The painter who works from life is forced to engage with his or her subject as a living and breathing entity, and this direct engagement should manifest this "newness" onto the canvas. This can allow the painting to be fluid, and allow for subtle nuances from the live model that can occur during these sittings. Hughes asserts that Auerbach seeks to discover these subtle nuances:

> *The work is full of observed facts of posture, gesture, expression, stare, the configuration of the head in all its parts, the tenseness or slump of the body, alertness or boredom, light and shadow: the endless drama of the I and the Other. The brush does not so much describe these as go to inquisitorial lengths in finding kinetic and haptic equivalents for them*.[74]

Auerbach is searching for the ever-evolving permutations in the human form, and he sees the human figure as in a constant state of movement. Hughes postulates that the "direct conversion of sight into mark" is the strength of his painting.[75] Painting from life allows the artist to record changes in a subject's expression and posture, as they happen. There is an immediate record in oil paint on the canvas, representative of the transaction between the sitter and the artist. The brushstroke made by the artist is an immediate response in oil paint describing moments in time.

[73] Hughes, Robert. *Frank Auerbach*. 1990 p.9
[74] Ibid, p.10
[75] ibid, p.7

Auerbach uses an abstract pictorial language to challenge the literal depiction of reality. Often he will use a large brushstroke to emphasise the mark as being the foundation of an oil painting. His mark is much more clearly delineated than Freud's, as he is not trying to literally describe the forms found in the real world. In contrast, Freud is using a more realistic and modelled technique to replicate a heightened sense of reality. Auerbach uses a pictorial language that is abstract, and uses the nature as a reference point. He emphasises the textural qualities of the oil paint to such a degree that it may become unrecognisable as a figure in an interior. He uses many layers of thick oil paint in such a way that it protrudes from the surface of the canvas creating a relief. Instead of the figure just receding into space, which occurs in Renaissance perspective, it also jumps out of the picture plane. He also wants to describe the figure as a three dimensional tactile entity, using oil paint as his medium.

In Auerbach's many layers of thick oil paint we may recognise his forms, but he is not using realist painting techniques to seduce us into thinking it is a real figure. Freud however, is deliberately using a realistic technique in describing the figure. He may want to trap us into thinking it is real. Freud pays more attention to the detail in the face, and the modelling of the form. The subtle variations in the tone in the face described by Freud give it a heightened illusion of three dimensions. Auerbach's tonal range is more limited, which can flatten out the three dimensional form of the figure. Auerbach's paintings oscillate between describing solid three dimensional objects, and flattening out of these objects at the same time.

Auerbach challenges Renaissance perspective by painting the figure and the background on the same picture plane. This technique flattens out the illusion of receding three dimensional space on the two dimensional picture plane. The figure and the background exist on the same picture plane and they become unrecognisable as separate entities. The figure and the background merge into one mass of oil paint. This also illustrates Panofsky's view of Renaissance space as being homogenised pictorial space which Auerbach is striving for. There is use of depth is his paintings, but it is a more shallow pictorial space than what is seen in Freud's paintings. Auerbach's forms do recede into the picture plane using receding perpendicular lines to denote depth, and at the same time they protrude from the surface of the canvas by way of thick application of the oil paint.

Auerbach also challenges a realistic depiction of nature by using an imaginary colour scheme. He uses some colours not derived from the natural environment of which he observes. In contrast, Freud uses a naturalistic colour scheme, as he wants to directly reference the real world. The colour of the skin tones that Freud uses to depict his figures is closer to what they are like in reality. Auerbach's colour can be artificially constructed, and may not conform to what he observes in reality. In using invented colour Auerbach reinforces

the notion that a painting is a construct, and he also heightens the emotional content of his work. He uses a contrasting colour scheme to create a dynamic and pulsating image that is suggestive of space, movement and time. Bright colours such as red leap forward, while darker cooler colours such as green recede into the picture plane. These contrasting warm and cool colours create a sense of pictorial depth. He does, however, use some elements of colour found in the real world to reference a real place or person. He is also distancing the painted image from reality by way of abstraction of form and colour.

In summary, Auerbach and Freud work in the tradition of Renaissance perspective, describing the illusion of three dimensional pictorial space. They may also derive their lines and forms which recede into a vanishing point, from observing nature. These artists use paint in a way that may challenge perspective, which uses a mathematical ordering of space. Perspective can be a system that can prevent the artist from showing the irregularities and movement of the human form. It does this by ironing out any irregularities in shape to fit in with the lines that it uses. It can predetermine the placement of the figure or objects within the picture plane. A subject may move during a sitting, or change position, and if the artist uses pre-drawn perspective system it may prove difficult to record these movements within this system. Both artists work from life, using an intuitive and organic approach. They respond to the changes in their subjects as they happen. They may want to challenge the idea of being locked into a mathematical and geometric grid.

We have seen how Auerbach and Freud, working within a figurative tradition of the Renaissance, are aware of its devices to achieve the illusion of three dimensions. Freud may borrow heavily from perspectival construction of space to achieve deep illusory three dimensional space and form. Auerbach uses a more abstract language to describe illusory three dimensional space and form, but still relies on perspective construction of pictorial space. His space is more a flatter illusory three dimensional space than Freud's. Both artists do not literally divide the canvas into perspective grid, but have an awareness of these rules. They paint from the live model over many sittings, allowing them to describe the constant changes of the human form. This presents a challenge to a geometrical ordering of space that could remove these subtle nuances seen in the live model. Essentially, they observe nature in real time which dictates the construction of the painting.

3.2 How does Char Davies utilise and challenge the theories of two and three dimensional space in her virtual environments?

3.2.1 Putting oil painting into the Cartesian grid

Char Davies is a painter who fuses art and technology to produce three dimensional immersive virtual landscapes. She is working within the tradition of Renaissance perspective in her paintings, which informs her three dimensional computer generated space. She uses the natural world as her subject. She has moved from painting into working with three dimensional virtual environments that convey a sense of immersive space and movement through time. She takes the idea of the natural world in her paintings into her three dimensional immersive environments in the works of "Osmose" and "Ephemere", which are real - time virtual reality environments.

Her approach to representing nature in two dimensions is by way of gestural marks, and she is trying to show a merging of the object with the background. McRobert informs us that she has a condition called myopia that causes the boundaries between objects and space to become indistinguishable.[76] This has led to her forms, and space around these forms, being combined into a unified pictorial space. Her depiction of two dimensional space illustrates Panofsky's view of Renaissance space as being homogenous. Her technique of combining the objects in the foreground with the background forming a unified two dimensional space is also seen in the paintings by Auerbach and Freud. This technique of dissolving boundaries in her paintings is carried over into her three dimensional computer generated environments.

Davies uses three dimensional computer generated space, borrowing from her aesthetics in her two dimensional paintings, to make time-based and immersive digital environments. McRobert states that Davies saw a three dimensional computer animated film called "Vol de Reve" made in 1983, and she "recognized the potential of three dimensional digital space for communicating (my) ideas about being enveloped in light and time and space", and she "began considering whether such technology might be an effective way to represent animated strokes of light-in-flux".[77] Thus she believes that there is a link between painting and three dimensional computer generated space. McRobert asserts Davies "considers how these strokes of colour or tone appear in virtual space and how she might create truly three dimensional paintings in which strokes coalesce into nearly-apprehensible form, and then dissolve in relation to the viewing subject's proximity and attention".[78]

[76] McRobert, Laurie. *Char Davies' Immersive Virtual Art and the Essence of Spatiality*. 2007.p.29
[77] Ibid p.11
[78] Ibid, p.15

Davies uses her painting, based on observation of nature and within the tradition of Renaissance perspective, as a reference in constructing virtual three dimensional spaces. She uses two dimensional images derived from nature, and applies them to Descartes' Cartesian grid in three dimensional computer generated space. Three dimensional computer generated space uses Euclidian geometric theory, Renaissance perspective and the xyz coordinates of Cartesian space as a basic structure for building three dimensional pictorial space.[79] This three dimensional space is illusory and is displayed on a computer screen. Two dimensional images derived from nature are added to three dimensional objects in her three dimensional environments. A three dimensional object based on the Cartesian coordinate system has width, length and depth. It is made up of a mesh of two dimensional polygons. These two dimensional images are applied to three dimensional objects, to give the illusion of a natural surface in her three dimensional computer environments.

A two dimensional image or texture applied to the three dimensional object can be thought of as if it is a painting on a flat plane, but it is a digital image. These two dimensional images used by Davies are constructed entirely inside the computer. They look like natural forms found in nature. Due to the time-consuming, expensive and complex nature of building immersive environments, often a team of experts is required. In the creation of her works Davies may have employed the use of three dimensional modellers and animators, and computer programmers to construct her worlds. Her input may be that of an artistic director and collaborator. The time-consuming process of building computer-generated environments can erode the touch of the artist. It is not evident if the imagery is done by Davies' hand. Her three dimensional worlds contain no trace of oil paint, yet they have a painterly feel, and resemble the look of her paintings. There is a stylistic relationship between her paintings and three dimensional virtual environments, but no evidence of her painterly mark.

Davies' intention is to transpose the aesthetics of her two dimensional oil painting into three dimensional computer generated space creating a unified pictorial space that illustrates Panofsky's assertion that the paintings of the Renaissance used a homogenous pictorial space. She arrives at this unified three dimensional pictorial space by using transparent objects. The digital textures applied to her three dimensional objects are transparent in places and opaque in others. The transparent areas of the textures reveal the computer generated background, unifying the foreground and the background. The dissolved boundaries in her paintings have been carried through into her three dimensional environments.

[79] Ibid, p.2

In summary, Davies' three dimensional environments comprise of two dimensional images derived from nature, in a three dimensional computer generated space. Her virtual worlds are informed by her paintings of nature. Like Auerbach and Freud, she may describe her natural forms by observing nature, and working within the tradition of Renaissance perspective. To construct her three dimensional computer environments she uses two dimensional textures based on the natural forms of nature which are applied to three dimensional objects. This virtual space makes use of Euclidian geometric theory, Renaissance perspective and the xyz coordinates of Cartesian coordinate system. Her virtual environments have the look and feel of her paintings; however do not contain elements of the real painting. In her two and three dimensional pictorial space there are indistinct boundaries between objects and the space around her objects, illustrating Panofsky's unified Renaissance space. Her main intention is to create a virtual environment where she can represent the brushstroke in computer generated three dimensional space.

3.2.2 The natural environment into the Cartesian grid

Davies is not content to construct her three dimensional environments entirely in the computer without reference to the real world. She uses two dimensional images based on nature and applies it to the three dimensional computer Cartesian grid. McRobert analyses Davies' work in "Osmose" and "Ephemere" and suggests that she wants to:

> *Create an immersive, interactive, visual/aural experience of nature-space. It must be a landscape where the user can sense unity with nature; where the edges of the mind and the enveloping horizon become one, where we can effectively pass on this experience of Nature as a sacred space, where we can hopefully alter the way people will see nature.*[80]

Davies is proposing a return to nature, and not a distancing from it, using three dimensional technologies. Three dimensional space that is constructed without reference to the real world may lead to a sterile, cold environment devoid of humanity. She echoes Auerbach's and Freud's beliefs in the importance in engaging with the real world. Davies' medium is a three dimensional virtual canvas that uses nature as a motif. According to McRobert, she wants to "compensate for our collective loss of nature/sacred space and for our increasing distancing from the natural world. Her goal is to attempt to re-establish this lost link by recreating a mystical experience of nature".[81]

[80] Ibid, p.14
[81] Ibid, p.14

Davies wants to emphasize the body and its connection to the natural environment. She does this by harnessing the use of viewers' breathing to navigate her worlds. The user accesses these worlds via an interface vest and a stereoscopic viewing helmet. Inside the helmet are two liquid crystal display (LCD) screens that create a stereoscopic effect. The vest and the helmet are linked to a computer. As viewers look around the computer calculates their point of view and adjusts it accordingly. As the user breathes in they rise in the virtual landscape, and as they breathe out they fall. In "Ephemere" the user navigates three worlds – the forest landscape, the subterranean earth and the interior body. Seasons change in these worlds, conveying a sense of time passing. In "Osmose" the user navigates worlds of text, a tree, and pod-like entity, and the code of the computer program reveals itself in the final world. The breathing of the user that controls their movements, reinforces the connection to the body whilst inside the virtual environment. The users are reminded that they need to activate a physiological bodily response to move in this virtual space.

Davies is highlighting the importance of nature, and yet she departs from it at the same time. In her virtual worlds, users can pass through objects and fly using their breathing. She is suggesting that the world around us can be a magical place, yet it retains traces of our real world. Davies states that "rather than approaching the medium as a means of escape into some disembodied techno-utopian fantasy, I see it as a means of return, i.e of facilitating a temporary release from our habitual perceptions and culturally-biased assumptions about being in the world, to enable us, however momentarily, to perceive ourselves and the world around us freshly".[82] She wants the users to have an experience that transcends the real world, yet is based on the real world. This is illustrated in the users' ability to fly through her virtual landscapes. She is providing a fantastical experience, and the users are not limited by the body's physical limitations.

Her environments show fragments of the natural world. Her natural forms look like nature, but are not literally described. She uses transparency, as discussed previously, to abstract her natural forms. According to McRobert, she abstracts her imagery so not to seduce users into thinking it is a replication of the real world.[83] Auerbach as well, uses this technique of abstraction in his paintings. He uses the real world as a point of reference and departs from it at the same time. He does this by using an abstract approach to apply oil paint to canvas. He is emphasising the painting as an artificial construct. Davies draws on her experience as a painter who erodes boundaries between her natural forms and the space around these forms. This sentiment is carried over into her virtual landscapes. She provides users with a semi-abstract depiction of nature, wherein the users can explore her environments not bound by the physical limitations of the body.

[82] Ibid p.1
[83] Ibid. p.73

3.2.3 Exploring the Cartesian grid

How does the user explore Davies' virtual environments? Instead of a mouse and a computer screen to navigate this space, the user explores with a stereoscopic head mounted display helmet and breathing apparatus. The sensation is one of being inside her worlds. The experience usually lasts for fifteen minutes, and the user is able to move through that space by moving the head mounted display, and activating the breathing apparatus attached to the user's chest.

Davies wants to provide an immersive and participatory experience. She proposes that her work can be "kinaesthetically explored by others through full body immersion and real-time interaction, even while such constructs retain their immateriality".[84] She achieves this by allowing the user to navigate through her three dimensional landscapes using a head mounted display and a breathing apparatus. The head mounted display controls the left and right, forward and backwards orientation, whilst the breathing apparatus controls the up and down orientation, and as stated previously, this causes a sensation of flying.

The users control their movements primarily by the head mounted display. McRobert submits that Ivan Sutherland in 1965 wrote down the principles of head mounted display "to serve as a looking-glass into the mathematical wonderland constructed in computer memory".[85] McRobert points out that between 1985 and 1990 NASA Ames Research Centre built a head mounted display. Their "objective was to develop a multi-sensory virtual environment workstation for use in space station teleoperation, telepresence and automation activities".[86] The head mounted display is a "headmounted, wide-angled, stereoscopic display system powered by a host computer and external hardware, such as graphics and sound synthesizing equipment, to create a digitally immersive space".[87]

The user is fed real-time three dimensional images from a computer that is attached to the head mounted display. Inside the head mounted display there is a liquid crystal display screen. Two separate images of the three dimensional environment are sent to the liquid crystal screen. The user processes these two separate images in their brain creating an illusion of three dimensions. The user has to ignore the fact that they are looking at two separate images. This illustrates Panofsky's premise that we perceive images two dimensionally. Each two dimensional image is processed separately by each eye. The images are merged together in the brain to create the illusion of three dimensions. It may take

[84] Davies, Char. *Virtual Space*. 2004.p.2
[85] McRobert, Laurie. *Char Davies' Immersive Virtual Art and the Essence of Spatiality*. 2007.p.4
[86] Ibid. p.4
[87] Ibid. p.4

the user some time to process the separate two dimensional images as a three dimensional image. This may lessen the sensation of immersion.

Davies has opted to use the head mounted display as a conduit to immerse the viewer into her virtual landscapes. This may give the viewer a sense of full body immersion. Another device to illicit immersion in the viewer is a Cave Automatic Virtual Environment (CAVE) environment. McRobert defines a CAVE environment as being a multi-person ten-foot-cube space where three dimensional virtual images are projected onto the surrounding walls and ceiling.[88] He states there is only one viewer who controls the three dimensional environment. The user wears a three dimensional input device that is tracked by remote networked computers which correct the positional perspectives as the user moves. McRobert believes that projection screens appear to be transparent, and there is an illusion of infinite three dimensional space. Davies may have opted for a head mounted display over a CAVE environment because she wants a greater sense of full body immersion. A CAVE environment exists in a real space, thus the users are reminded of a real place. With a head mounted display that restricts vision and hearing, the sense of being in a real space may be lessened.

I have explained the technology Davies uses to display her three dimensional landscapes, and I will proceed to explain how the user interacts with this space. Davies defines virtual space as being "immersive" using computer-generated artificial environments and their associated equipment, wherein the viewer can enter into this space. She asserts that virtual space is a "spatiotemporal arena wherein mental models or abstract constructs of the world can be given virtual embodiment – visual and aural – in three dimensions and be animated through time".[89] She believes that the users are activating all their senses in her virtual worlds, and are able to activate events as they encounter them.

Events are triggered as users pass through objects or levels. These events happen in real-time. The users can enter into her three dimensional objects that trigger an event to happen. For example, entering a three dimensional seed-like pod may cause it to open up to reveal its interior. The users might be caught in a stream of light that carries them to another place or level in her virtual worlds. As the users pass through one level they may instantaneously materialise into another level. Levels are discrete areas in a virtual world that are linked to each other.

Exploration through Davies' virtual worlds conforms to Manovich's proposition that navigating through space involves a narrative being revealed and encountering real-time interaction

[88] Ibid, p.100
[89] Davies, Char. *Virtual Space*. 2004. p.2

along the way. Journeying through her space takes fifteen minutes from beginning to end. The longer the users are immersed in her worlds, the more that is revealed travelling through this illusory three dimensional space. The users have to learn how to navigate this unfamiliar space, as it differs from being in the real world. They may have to take more than one fifteen minute attempt at exploring this space to discover its vast terrain, and work out what is possible or not.

"Osmose" and "Ephemere" are made up of discrete levels or spaces. These levels are non-linear in structure. McRobert asserts that the up/down dynamics in Davies' worlds challenge the linear depiction of three dimensional space. [90] As stated previously, the users can fly up and down using their breath. As they descend or ascend they pass from one level to the next. These spaces do not reside side by side in virtual space on the computer, and are discontinuous. This illustrates Manovich's proposition that three dimensional space is made up of discrete, separate places. As the users pass through one level they may materialise into another level. This non-lateral movement is called teleporting. It involves the instantaneous movement from one level to the next. The users may be in one level, and they may pass through an object that triggers another level to come into view. This non-linear depiction of three dimensional space is in contrast to Renaissance perspective which is linear and fixed. Two dimensional pictorial space cannot be explored in real time, and its viewpoint cannot be altered.

3.2.3 Challenging the Cartesian grid

Davies suggests we still conceptualise the world around us in terms of the old Newtonian/ Cartesian paradigm which postulates separate, solid objects in empty space.[91] Her view of three dimensional space resembles Manovich's concept of three dimensional space as empty Renaissance perspective space based on the Cartesian coordinate system, and this space comes into being once objects are added. Davies believes that this way of thinking has infiltrated its way into constructing three dimensional computer generated immersive space. As stated previously, three dimensional computer generated space uses Euclidian geometric theory, Renaissance perspective and the xyz coordinates of Cartesian space as a basic structure for building three dimensional pictorial space.[92] Davies believes this leads to a "never ending quest for visual realism".[93] As a result three dimensional computer generated imagery can be mathematically exact based on geometric primitives.

[90] McRobert, Laurie. *Char Davies' Immersive Virtual Art and the Essence of Spatiality*. 2007.p.79
[91] Davies, Char. *Virtual Space*. 2004. p.2
[92] Ibid, p.2
[93] Ibid, p.2

Panofsky asserts that Renaissance perspective is a human construct and symbolic of a scientific/mathematical approach to depicting nature. This geometric ordering has infiltrated the design of three dimensional computer generated pictorial space according to Davies and Manovich. Renaissance perspective is made into three dimensional computer space by adding the Cartesian coordinate system. It enables the representation of three dimensional objects and space in the computer environment. If we go back to looking at a two dimensional polygon that has length and width, we extend that into three dimensional computer space by adding a depth. Using the Cartesian coordinate system, there are three x, y and z coordinates for the three dimensional object. The fixed system of two dimensional pictorial space has developed into three dimensional computer generated pictorial space. Now the users can navigate through this space, according to Manovich, by way of computer technology. Its view can be changed and explored over time.

Davies challenges this geometric Cartesian space by dissolving boundaries between her objects, and space around these objects. As stated earlier, Davies' aesthetic principles are guided by her physiological experience of the world. As McRobert points out, her eyes are myopic which causes things to go out of focus, and objects and space fuse together. Near and far are indistinguishable from one another; solid objects become semi transparent and blend with each other. There are no hard edges. McRobert states that Davies "explores techniques based on transparency and the non-linear dynamics that break through our once iron-clad imaginative obsession with Euclidean geometry, and hence through our mathematically rigid conceptions of space/time".[94] Borders between space and objects are gently eroded in her virtual worlds, wherein the users can enter virtual objects and travel along with moving objects. One can penetrate the interior of objects, such as a boulder, that is impossible in reality.

Davies aims to unify the objects in her three dimensional environments with the space around them. Three dimensional spaces can be thought of as void until objects are added. There is no relationship between the objects once they are created, and the void that surrounds them. Three dimensional space is empty without objects in that space, much like a blank canvas. However, lying at its heart is the three dimensional Cartesian grid as its invisible structure. Manovich claims that this three dimensional pictorial space, which Davies uses, is more like the clumped space of antiquity. He means that the paintings of the antiquity era, before the Renaissance, biased the depiction of objects over the space around them. Thus the objects were arranged in clusters, with little space around them. Davies presents a challenge to this by dissolving boundaries between her objects and the space around her objects. This provides a unified pictorial space that resembles Panofsky's homogenised space of the Renaissance.

[94] McRobert, Laurie. *Char Davies' Immersive Virtual Art and the Essence of Spatiality*. 2007.p.7

Davies reinforces the idea of three dimensional space being an artificial construct, according to McRobert, by deliberately abstracting her pictorial language.[95] This is done intentionally to avoid creating the perfect geometrical image, and therefore prevents the users being too seduced by the imagery as to forget where they are. As stated previously, she does this by using transparency to dissolve the boundaries of her objects, and the space around these objects. She is also showing fragments of reality derived from the real world. Her forms may resemble natural forms, but they become otherworldly at the same time. Davies is challenging the idea of perfect reality by distorting or abstracting her three dimensional computer images of nature. She also lets the users see the computer code and Cartesian coordinates in "Osmose". This reinforces the artificial construct of the digital environment by reminding us that computer code is used to construct the imagery.

In Davies' virtual landscapes she challenges the rigid depiction of three dimensional space, however she also relies on its geometric based structure. Her virtual realms involve precise mathematics in the form of computer code. The computer's precise mathematical logic in constructing virtual worlds allows for an exactness to the three dimensional forms that may give them an aesthetic beauty. This mathematical construction is virtual space's strength in that can render a scene with such preciseness. It echoes the straight and receding parallel lines of the perspective grid. Davies also displays the Cartesian grid as an object of aesthetic beauty in "Osmose". The users can fly through this grid and see how three dimensional space is structured. On the one hand she is highlighting the geometry, and on the other trying to dissolve it.

We have seen that Davies uses the Cartesian grid developed from Euclidian mathematics, Renaissance perspective and the Descartes' Cartesian coordinate system to immerse the users in her virtual worlds based on the natural world. On the one hand she delights in showing the users the Cartesian grid that has an aesthetic beauty all of its own, yet she subverts this paradigm at the same time by dissolving the boundaries between the objects and the space around the objects. She does this by using transparency in her objects. The users are able to navigate through this space, triggering events in real time, using head mounted display and breathing apparatus. She wants to totally immerse the viewer in her worlds. Central to her vision is creating images that maintain a link to her painting practice. She wants to create brushstrokes in flux in three dimensions, based on the natural world.

[95] McRobert, Laurie. *Char Davies' Immersive Virtual Art and the Essence of Spatiality*. 2007.p.73

3.3 Summary

In chapter four, I will be applying the theories of two dimensional pictorial space, and the techniques of Auerbach and Freud, in construction of the two dimensional portraits. I will be working within the tradition of Renaissance perspective that depicts the illusion of three dimensional space on a two dimensional picture plane. However, I will also use direct observation of nature to define my pictorial space. As well, I will be painting the portraits from the live model, using an intuitive and organic approach to challenge the mathematical and geometric ordering of perspectival space. I will be using a textural approach to building up the form of the head, borrowing from Auerbach and Freud's technique. As well, I will be using Panofsky's view of pictorial space as being non-linear and homogenised to guide me.

Also in chapter four, I will proceed to use the theories of two dimensional and three dimensional space, and the techniques of Char Davies, to construct the three dimensional immersive environments. I will be using her process of merging oil painting based on the real world into three dimensional computer generated space to animate the brushstroke. I will be drawing on Davies' technique of dissolving boundaries between the three dimensional object, and the space around that object, using transparency. This will present a challenge to Manovich's premise of three dimensional space being a collection of separate objects that bear no relationship to the space around them. I will create a unified pictorial space by merging the three dimensional objects and the space around them. This will illustrate Panofksy's view of the Renaissance space as being homogenised and coherent. Like Davies, I will be highlighting the geometric structure of three dimensional space by revealing its geometric structure, at the same time I will be challenging its premise.

CHAPTER FOUR

4. Integrating the theories of two and three dimensional space, and techniques of Auerbach, Freud and Davies to the multimedia installation CAVE Painting

4.1 Overview of CAVE Painting

The integration of two dimensional oil painting and three dimensional immersive environments was presented in the form of a multimedia installation called CAVE Painting. CAVE Painting took the form of a Cave Audio Visual Environment (CAVE). McRobert defines a CAVE as a multi-person ten-foot-cube space where three dimensional virtual images are projected onto the surrounding walls and ceiling. There is only one viewer who controls the three dimensional environment wearing an input device that is tracked by remote networked computers. The perspective of the three dimensional scene changes to correspond to the position of the viewer within the CAVE.[96]

The CAVE environment was used to create a sense of semi immersion. However, the three dimensional environments were in a fixed position that did not change their perspective when the user moved. There was no tracking device. The viewer was able to change their position in relationship to the imagery; however the imagery did not change its position in relation to the viewer. This was to reinforce that CAVE Painting was to be viewed as if looking at a two dimensional painting on a wall. There was not a projection on the ceiling and floor. It was intended to not totally immerse the viewer, reinforcing the real space behind the installation. I did not want to give the viewer a totally disembodied experience, that may occur with a head mounted display used by Davies.

The sense of immersion was achieved using the format of an open ended cube which the viewer enters. The scale of the space was that of a small room, so the viewer's whole body was encapsulated. The projections were placed on the four screens of the inner side of the cube, and the four paintings hung in the centre of each visual screen. The integration of the projections and paintings allowed CAVE Painting to be read as one piece, leading to a synthesis between the real and virtual. Yet on closer inspection of the installation, the real paintings and the virtual digitised paintings were seen as separate entities making up a unified whole. The ceiling and the floor were the only surfaces not to have projections and paintings, as I still wanted to allow the viewer a sense of being in a real physical space.

[96] McRobert, Laurie. *Char Davies' Immersive Virtual Art and the Essence of Spatiality*. 2007.p.100

I chose to use a CAVE environment as I wanted the viewer to feel connected to a real space and objects, and to allow it to be viewed by more than one person at a time. Grau points out that the "one advantage of mixed realities is that the observer is not obliged to wear an oppressively heavy HMD or forced into the computer-generated body of an avatar; mixed realities make orientation easier while still allowing interaction with new fields of action".[97] HMD's may elicit a feeling of disembodiment, as the real world is shut out. CAVE Painting allowed the user to view the work in a real space. The real oil painting could only be viewed in a real space. Thus using a HMD, as in Davies' work, would not allow for the experience of the real painting. HMD displays are more suited for fully immersive virtual environments. CAVE Painting was meant to be viewed by more that one person at a time. There was room for the viewer to move around and enter and leave at any time. Also several users at once were able to view the work. It was a shared public experience.

I chose to display the three dimensional environments and paintings in real space, and not clutter up the space with technology that may have detracted from the work. As well, the seductiveness of the imagery in CAVE Painting was able to transport the viewer into "the suggestive space of images".[58] Emphasising the brushstroke in the portraits and simultaneously in the three dimensional projections may have focused the attention of viewer to the imagery, and not the technology. Configuring the imagery in a cube formation, and it all moving in the same direction, may have elicited a sense of semi immersion. The installation was the size of a small room, and viewers were partially enclosed when they entered. There were four gaps at the side of the projection screens for viewers to come and go at will, and to reveal the real space in which it was enclosed.

Important to the CAVE Painting was the merging of real and virtual objects. I drew on Paul Milgram and Fumio Kishino's definition of mixed reality to explain the merging of the painted object with the three dimensional computer generated environments derived from the paintings. They define mixed reality as one "that involves the merging of real and virtual worlds".[98] They present us with several definitions of what mixed reality is: 1. Monitor based (non-immersive) video displays of the real world on which computer generated images are overlaid.[99] 2. Video displays of the real world using immersive head-mounted displays (HMD).[100] 3. HMD's which are see-through and on which computer images can be superimposed allowing the real world to be seen.[101] 4. See-through HMD's using video of the real world rather than optically viewing the real world.[102] 5. Completely graphic displays to

[97] Grau, Oliver. *Virtual Art, From Illusion to Immersion*. 2003. p.245
[58] Ibid, p.247
[98] Kishino, Fumio and Milgram, Paul. *A Taxonomy of Mixed Reality Visual Displays*,1994, p.3
[99] Ibid, p.3
[100] Ibid, p.3
[101] Ibid, p.3
[102] Ibid, p.3

which video of the real world is added and are either completely or partially immersive.[103] 6. Completely graphic displays but partially immersive environments, (large screen displays), in which real physical objects in the user's environment play a role in the computer generated scene.[104]

CAVE Painting resembled Milgram and Kishino's definition number six of a mixed reality display. It did this by using completely graphic three dimensional projections of the digitised paintings combined with real physical objects, which were the portrait paintings. The three dimensional projections were projected large scale on four screens on to the paintings via four projectors attached to the ceiling.

4.1 CAVE Painting, RMIT University, John Derrick, 2010.

[103] Ibid, p.4
[104] Ibid, p.4

The experience of CAVE Painting was that of a synthesis of real objects and virtual space in a multimedia installation. To achieve this I meshed the portrait (real object) with three dimensional computer generated background (virtual object). This was done by digitally sampling the real oil paint textures and applying them to wireframes in three dimensional space, and then projecting this digital doppelganger back onto the original painting. Having the unity of the painting and the projections was of utmost importance, but on close inspection of the installation it was apparent that there were real paintings coupled with their digital counterparts. There was no attempt to hide the how the installation was constructed. It was intended to illustrate how the real painting and the virtual projection can mutually exist, but be separate entities at the same time.

In summary, the imagery in CAVE Painting was a representation of four people in oil paint, combined with three dimensional computer projections. CAVE Painting utilised four projection screens hanging from the ceiling in a cube formation, with the dimensions 163 by 123cm for each screen. The screens were constructed out of canvas creating a consistency between the oil paintings and the screens. The screens were be suspended at 54cm from the roof to the top of the screen. There were four projectors attached to the ceiling at a distance of 306cm each with a four different three dimensional projections running from four separate computers. Each three dimensional projection matched its corresponding painting.

The paintings were suspended from the roof, and sat in front of and in the centre of the screens. The projection screens were arranged in a cube, and the screens did not touch at the ends but there four small gaps in the corners where the viewer could enter. The four projections were meshed with the four paintings, tying them all together. There was a room within a room, and it was darkened to accentuate the light of the three dimensional projections. The paintings were lit by the projected light in the three dimensional projections, creating a unified multimedia installation. CAVE Painting illustrated the integration of two dimensional and three dimensional pictorial space.

4.2 The two dimensional portraits

We have seen in chapter one how Euclid's theory of parallel lines that merge at a vanishing point was adopted by Alberti in the rules of perspective. Alberti's perspective uses this vanishing point where all the parallel lines recede into infinite space. Figures and objects placed within these guidelines recede as they get closer to the horizon line. This system was based on straight lines representing visual rays emanating from the eye. Panofsky informs us that this system is mathematical and may not be how we perceive reality. He believes that we

perceive space in a non linear way, and our senses do not know how to comprehend infinite space.

Drawing on Renaissance perspective helps in the depiction of illusory three dimensional space on a two dimensional picture plane. Panofsky defines perspective as “a planar cross section through the so-called visual pyramid; the apex of this pyramid is the eye, which is then connected with individual points within the space to be represented”.[105] This planar cross section was the canvas surface on which the portraits were painted. An imaginary horizon line and a vanishing point on the horizon line were established. Imaginary lines were ascertained from the corners of the picture plane to the vanishing point. By using these rules the human head receded into pictorial space, giving the illusion of three dimensions. These guidelines were not directly drawn onto the surface of the canvas. The form of the head was painted with an understanding of perspectival rules. As well as drawing on perspective, the contrasting tones of light and dark paint created an illusion of three dimensional form. The contrasts in the highlights and the shadows caused by natural light hitting the face, also gave the illusion of three dimensional form.

The human head was the primary focus and the background was void to accentuate the detail in the face. The background fit Manovich’s view of three dimensional pictorial space as being void until objects are added. However, the head and background were connected by using similar marks and painting the background and foreground simultaneously, illustrating the unified space of Renaissance perspective as outlined by Panofsky. The textural method of painting employed by Auerbach and Freud, as outlined by Hughes, was used to describe the three dimensional form of the head. The artist’s brushstroke represented an intuitive paradigm which challenged a bias based solely on the geometrical construction of space, as seen in Renaissance perpspective.

I observed the form of the head through direct observation. Hughes believes that painting from life allows the artist an unfiltered glimpse of reality.[106] The minute variations in movement can only be seen by many painting sessions from the live model, whereas photography captures the image in a single moment. I chose not to use photography as a tool from which to develop the paintings as the photograph can remove detail of the subject and flatten out its form. The photograph can edit out a large amount of information before the artist intervenes. As well, being able to walk around the subject allows for a greater understanding of three dimensional form, whereas a photograph is from a static, fixed viewpoint.

[105] Panofsky, Erwin. *Perspective as Symbolic Form*. 1991. p. 28
[106] Hughes, Robert. *Lucian Freud, Paintings*. 1988. p.8

Direct observation of the live model challenged the geometric ordering of space used in perspectival construction. It did this by attempting to capture the movement of the head as it was observed. I did not predetermine the pose or position, or draw the perspective grid on the canvas. I let the subjects determine their own positions, and I did not require them to remain absolutely still. The intuitive and gestural marks in the four portraits also challenged this notion of a mathematical ordering of space. Perspective can be a system that can prevent the artist from showing the movement and organic depiction of the human form. It may iron out any subtle nuances observed in real time, to fit in with the lines of the perspective grid.

I did not grid up the canvas with receding parallel lines, but painted directly onto the surface observing the live models. I had an awareness of perspective rules to guide me, but did not use them literally. I noticed the movement and changes in the subjects, and recorded them as they happened. This is evident in the processes of Auerbach and Freud, allowing them to record the body in a state of flux. I did not use any straight lines, and those that I did encounter, I curved slightly. This also illustrated Panofsky's view of pictorial space as being non-linear. He proposes that we see parallel lines as slightly curved as they hit the concave surface of the retina. Freud uses the same technique to dramatise his paintings, and to challenge Renaissance perspective. The angles of his straight lines sometimes do not recede correctly to the vanishing point creating disunity between the foreground and the background. This approach created drama and tension in the paintings. Working from life, using an intuitive and gestured approach to the brushstrokes on the canvas, was used to challenge a bias based on the geometrical ordering of space.

The subject's face and the background were executed using similar stylistic marks, and painted simultaneously to create a relationship between the two. This achieved Panofsky's homogenised space of the Renaissance. Both Auerbach and Freud integrate the background and the foreground as they paint, to create continuity of pictorial space on the picture plane. They achieve this by using a consistent brushstroke. I painted the detail on the face, and worked on the empty space of the background simultaneously. I used the same colour in parts of the face and in the background, and thus created a relationship between the two.

The background was darker and cooler in tone to that of the face. This effect gave the impression of the face receding into the background. I was drawing on Freud's technique of describing receding space and heavily modelled form to create the illusion of three dimensions. I did not depict any angles of the floor or ceiling in which the model was painted. I kept the background void and used the warm/ cool contrasts in colour tone to achieve the effect of receding space. I also built up the form of the face using subtle variations in tone, which is a device used by Freud to achieve an illusory three dimensional appearance. I kept

the background void to accentuate the three dimensional form of the head. Unlike Manovich's pictorial space that is made up of separate forms that bear no relation to the space around them, the foreground and background in the portraits were unified. The background in the portraits was to be imaginary, and not based in any particular time or place. If I had included objects in the background it might have alluded to a particular time and location.

4.2 "Matt" 2007. Oil on canvas, 63 by 63cm

4.3 "Laurie" 2008. Oil on Canvas, 63 by 63cm

I used an imaginary colour scheme to reinforce the notion that a painting is a construct, and although the painting was derived from nature it was not important to replicate it truthfully. This technique of using imaginary colours is used by Auerbach to challenge the literal depiction of nature. He uses nature as a reference point, but abstracts it by his own idiosyncratic use of colour and exaggeration of these natural forms. There were many different colours that made up the four portrait paintings such as blues, yellows, oranges, and greens. There were contrasting colours: cold blue tones with hot warm tones. These colours competed with each other optically, causing the illusion of movement and depth, and reinforcing the notion of the painting as an artificial construct.

The colour schemes in the portraits were exaggerated so that may have created an emotional response in the viewer. Predominantly warm colours were used to show the flesh of the subjects was alive and pulsating. The darker colours were used in the background to create a sense of depth. The warm, lighter colours of the head appeared to pop out of the cool, darker colours of the background. I emphasised the colours which were layered on top of each other in each successive coat. I let one layer dry before adding the next layer, as this allowed for the colours to remain separate. This revealed the process of building up an oil painting in distinct layers. These colours, when digitized in the three dimensional environments, became luminescent when the projected light passed through them.

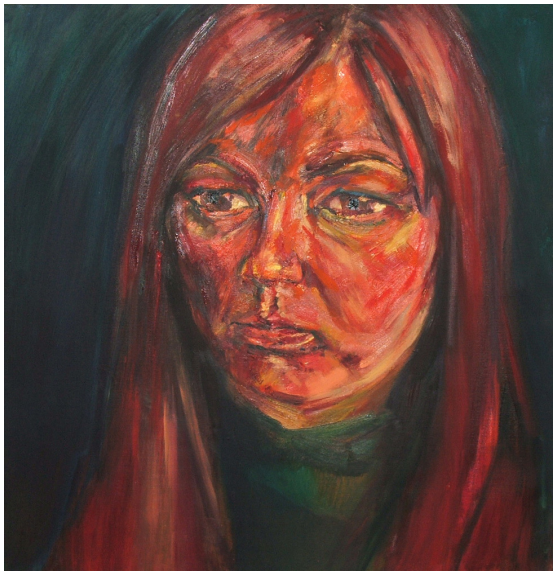
I used the texture of the oil paint to imply the three dimensional form of the head. Auerbach describes his forms in many thick layers of oil paint. His paintings involve the heavy layering of oil paint causing the paintings to be in high relief. He builds up the form of the body using the textural qualities of the oil paint as a device to achieve this. His paintings become sculptural, and one is tempted to reach out and touch them. His figures become solid masses of oil paint that come out, as well as recede into the two dimensional picture plane.

I achieved this textural quality by using the oil paint directly from the tube and not thinning it down with turpentine. Freud also uses this textural method of applying oil paint to build up his forms. Freud's technique in applying oil paint to a canvas surface is a slow process of building up layer after layer of oil paint using a coarse brush. He pushes the paint around, wet on wet, blending one wet paint layer with another successive wet paint layer - to build up his sculptural forms. The blending of different shades and colours of wet oil paint moulds the paint into semi-relief, much akin to a sculptor using clay in three dimensions. The oil paint, used directly from the tube, and not thinned down with turpentine, enables the paint to retain its textural qualities. The paint absorbs oxygen from the atmosphere when it dries, and hardens and retains it shape. Thus Freud is giving us a visceral and tactile experience of the oil paint. He wants to confront the viewer with what it is like to engage with the living and breathing human. This textural device was used as an aid in creating illusory three dimensional form of the head.

This textural device was used to accentuate the three dimensional form of the subjects in the four portraits. I challenged the premise of receding space achieved by using perspective rules, and at the same time utilising it to achieve depth in the four portraits. The form of the head protruded from the canvas and simultaneously sat within the receding cool tones of the background, creating a spatially unified pictorial space.

In summary, I have shown that in the construction of the portrait I have been aware the rules of perspective to create pictorial depth, as developed by Alberti. These rules were not used

literally to divide the canvas frame, but were held in awareness to aid in presenting the illusion of depth. It was intended to challenge the geometric ordering of this perspectival space, by using an intuitive and gestural painterly technique used by Auerbach and Freud. I was using direct observation of the live model to capture the movement and subtle nuances of three dimensional human form, and the space that it occupies. I used textural techniques, as used by Auerbach and Freud, to create the illusion of a solid three dimensional form protruding from the canvas. However, I also achieved pictorial depth by using the different optical properties of warm and cool colours. The end result was four portraits depicting protruding and receding human heads, creating a unified pictorial space as outlined by Panofsky. The next part of the construction of CAVE Painting involved building the three dimensional immersive environments, and placing the digitised portrait inside three dimensional computer generated environments.



4.4 “Carla” 2008. Oil on canvas, 63 by 63cm

4.5 “Julie” 2007. Oil on canvas, 63 by 63cm

4.3 The three dimensional immersive environments

We have seen in chapter one that Rene Descartes’ Cartesian coordinate system extends the Renaissance perspectival space into three dimensional computer generated pictorial space. The Cartesian coordinate system represents objects that are composed of x, y and z coordinates and thus allows objects to have width, depth and length. Three dimensional

objects are created using three dimensional computer software. I have used this three dimensional space to build the three dimensional immersive environments.

I have attempted to merge the tactile properties of oil painting with the immateriality of three dimensional computer generated light based environments. The exploration of the relationship between the physical and the non – physical has been important to my enquiry. The physical manifestations of the person in the portraits are combined with three dimensional computer generated pictorial space which is light-based and ephemeral. With the portraits completed, I have digitised the portraits and inserted them into three dimensional computer generated environments. The three dimensional environments have been constructed using Unreal game engine software used in creating three dimensional computer games.

We see that Davies' concern is about animating the brushstroke in three dimensional virtual space. She believes that three dimensional computer environments "might be an effective way to represent animated strokes of light-in-flux".[107] The portraits, through the adding of the three dimensional computer generated space, have become alive and animated. I have achieved this by digitising the oil paint textures of the portraits and animating them over three dimensional wireframes in the Unreal game engine software. However, Davies does not use digitised oil paint in her virtual landscapes. Her virtual landscapes only have a painterly look. She only alludes to two dimensional painting, and draws on her aesthetics informed by her myopia, in representing the brushstroke in three dimensional pictorial space. In the CAVE Painting it has been of importance to show the artist's brushstroke, and has been achieved by digitising the textures of the real paintings and inserting them into three dimensional pictorial space.

I have constructed the digitised painting textures by taking close-up images of the real oil paintings with a digital camera. A two dimensional texture is a two dimensional image that is applied to a three dimensional object's wireframe to create the illusion of a surface. Davies has used this approach, using two dimensional images based on nature, and applied it to the three dimensional Cartesian grid. As I have stated, her textures may have been constructed entirely inside the computer environment, and may contain no trace of her hand. The oil paint textures derived from the portraits have been manipulated in Photoshop, a two dimensional image manipulation program. I have zoomed in on the texture, reinforcing the artist's touch and the tactility of the oil paint.

[107] Ibid p.11

4.6 Painting Texture used in Three Dimensional Computer Projection

The digitised close-up of the portrait was brought into Photoshop and an image of 512 by 1024 pixels was created. The 512 by 1024 pixel format allowed for the texture to be imported into the game engine software. This file was not so large that it might impede the running of the game engine when projected. The portrait has been repeated in the texture, and one of the repetitions has been inverted. Inverting one half of the image abstracted the image, becoming less recognisable as a portrait. As in with Davies' work, I am asserting the artificial nature of two and three dimensional pictorial space by abstracting the image. Davies uses abstraction in her images of nature. Her natural forms are fragmented and intertwined to create a fantastical virtual space.

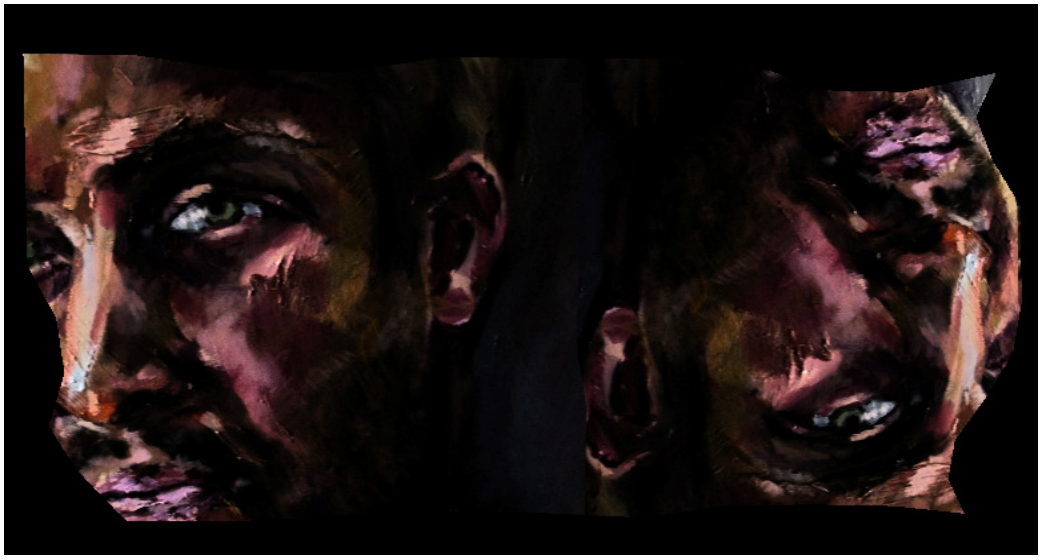
I have used and challenged the geometric ordering of two and three dimensional pictorial space built around Euclid's theorems, Renaissance perspective and the Cartesian coordinate system. I have used the geometric ordering of pictorial space which has been illustrated by a hard edge running down the centre of the texture. I have challenged the geometric ordering of pictorial space by applying a painterly approach to depicting the figure and inserted it into a geometric Cartesian space. Thus the hard edge represents this geometric paradigm. The painterly brushstroke of the texture represents the intuitive and organic response to the live model. Davies has also taken this approach in her virtual landscapes. On the one hand she shows the user the Cartesian grid that divides up three dimensional computer generated

space. On the other hand she uses natural forms and transparency to soften this hard edged space.

Realism was important to anchor the three dimensional environments in the real world but it was departed from at the same time. In the three dimensional environments I revealed close-up digital textures of the paintings that created an abstraction of the image, reinforcing that the scene was an artificial construct. Davies uses realism in the form of the landscape to reference the real world yet she departs from this at the same time. She does this by abstracting her imagery, and providing an experience that is not based on the laws of the natural world. The human head in the portraits represented the artist's engagement with the natural world. I abstracted the portraits by enlarging the detail of the textures of the paintings, and imported it into the three dimensional immersive environments. Thus when the digital textures were projected large scale, the form of the human head was unrecognisable and the individual brushstrokes stood out as an abstract pattern. This reinforced the projections as an artificial construct derived from nature.

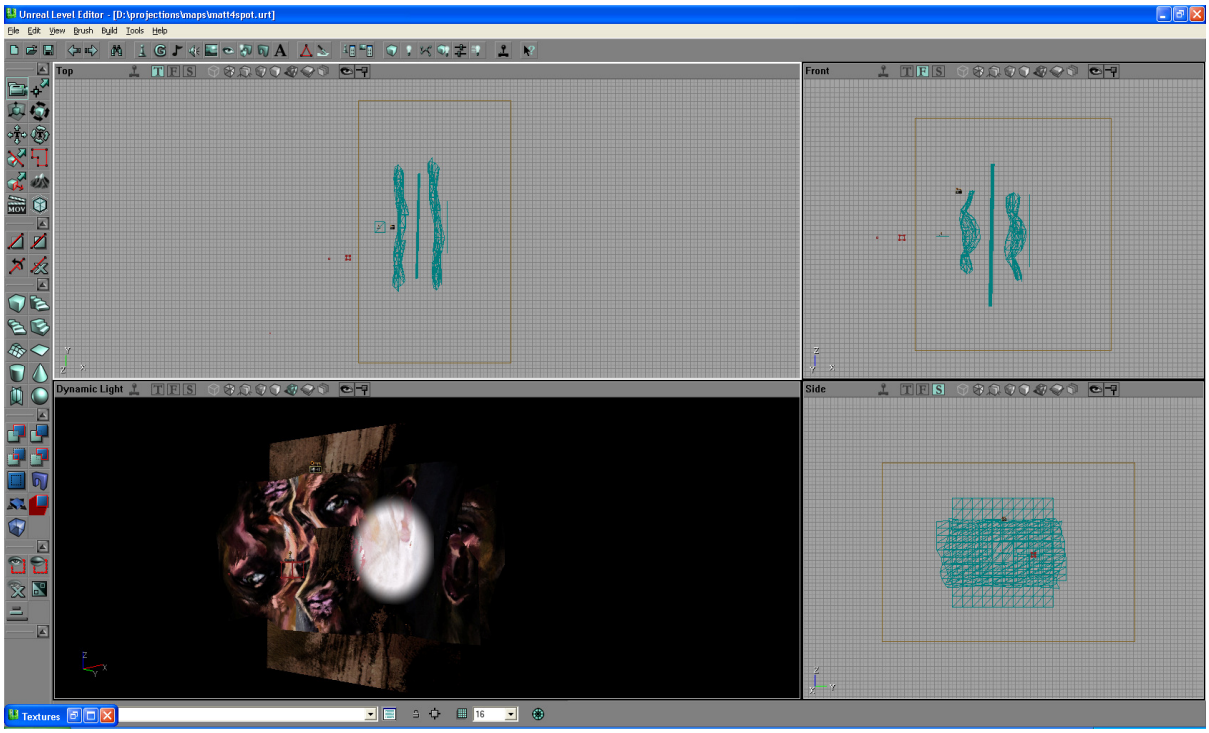
I have also challenged the geometric ordering of space by using transparent textures in the three dimensional environments. I have used three transparent texture layers for each projection that has enabled the viewer to see through them, revealing the layers beneath. This effect created a sense of depth, and illustrated the process of building up of an oil painting using many layers. I have demonstrated how processes of two dimensional painting can be used to build a painterly three dimensional environment. This painterly process, used by Freud and Auerbach to build a rich textural surface, was used in the three dimensional environments. However, the digital surface was flat when projected on the canvas screens, and the raised texture of the oil paint in the projections could only be implied as it was illusory three dimensional pictorial space.

Transparency was used to show the texture layers underneath. This was achieved using alpha channels. Alpha channels are used in the texture that directs the computer where to make the image transparent. An alpha channel is a black and white copy of a colour image that is included in the file making up the colour image. The black areas are transparent and the white areas are opaque. This is the strength of computer rendered imagery, in that it produces wonderful transparency. Three layers only were used in each three dimensional environment so as not to cause a visual overload, and detract from the real painting in the middle of the projection. A sense of depth would be reduced if there were too many layers and would crowd out the background, limiting the illusion of depth. However, like Auerbach, I chose to depict a relatively shallow three dimensional pictorial space to challenge the Renaissance of idea of receding space, and to reinforce the idea of the painting as being an artificial construct.



4.7 Painting Texture used in Three Dimensional Computer Projection with Transparency

Similar to the oil paint application in the real paintings, the digital textures were layered to create an illusion of three dimensional forms. These digital textures were added to three dimensional wireframes in the virtual environments. I approached the construction of the three dimensional wireframes like the construction of oil paintings, using simple forms to build the pictorial space. The three dimensional wireframes were created in Maya, a three dimensional modelling and animation software package. The wireframes were built in Maya using two dimensional polygons. The greater the number of polygons correlates with more detail in the shape of the three dimensional object. I deliberately used simple geometry in the wireframes, as I wanted the detail to be in the digitised paint textures that go over the wireframes. Keeping the polygon count low in the three dimensional environments was important so as not to slow down the computer's performance when they were projected. The higher the detail in the geometry the more computations the computer has to do, resulting in a slower performance.



4.8 Three Dimensional Wireframes with Painting Textures in Unreal Game Software

I have shown some of the geometry of the wireframes to highlight the mathematical depiction of pictorial space that is evident in the Cartesian Grid. This was evident when the three dimensional computer environments were projected, revealing some of the hard edges of the wireframes in areas that were linear. Two of the three wireframes were slightly warped, so as the digital textures moved across them it created the illusion of a curved surface. I also wanted to suggest that the three dimensional object that the primary constituent in virtual three dimensional computer generated environments by creating objects with width, length and depth. I used Panofsky's proposition that pictorial space is curvilinear and non-linear to inform their construction. The middle wireframe was kept planar and this layer was kept the same in the four three dimensional computer environments to tie them all together. This middle wireframe was an extreme close-up of one texture, derived from the portrait.

The three dimensional computer environments represented the brushstrokes in flux as if the viewers were watching the artist paint the scene in front of their eyes. This represented Davies' idea of showing the animated brushstroke in virtual space. The game engine can be programmed to animate the textures in real-time. The game engine slowly pans the textures over the wireframes in a continuous loop. This gave the impression of layering and placing of brushstrokes on a virtual canvas. The digital textures swam effortlessly over the virtual three dimensional wireframes: left to right, up and down, right to left. There was no beginning or end, only the eternal movement of the virtual paintings. The painting is the core fundamental

element of the CAVE Painting installation. Three dimensional virtual space extends the oil painting by situating it in a virtual arena where the elements of time and sound have been added. Two dimensional oil painting has now been emancipated from its static hibernation, and essentially becomes an immersive and time-based medium.

The user cannot interact with the three dimensional environments via an interactive device, unlike in Davies' work where users can trigger events as they navigate her space. This presented a challenge to Manovich's proposition that the way of navigating through three dimensional space is triggering actions and events in real time. The three dimensional objects in CAVE Painting have been made without the ability of the viewer to interact with them. They were made to be viewed only when they are projected, thus maintaining a link to Renaissance painting that is viewed on a wall from a fixed perspective. Renaissance perspective is uses a static viewpoint and cannot be moved. I combined this fixed view with moving three dimensional virtual space that was non-interactive.

I put the digitised oil painting into a black three dimensional void. The black background was uniform and did not reference a particular place or time. This space represented the endless infinite space of Renaissance perspective as outlined by Panofsky. A black texture was applied to a three dimensional rectangular wireframe in the Unreal game engine. This space was subtracted from a three dimensional void in the game engine software. This space correlated to beginning the portrait paintings and starting out with a blank pictorial space. The three dimensional void was thought of as empty space, where objects were to be added. This illustrated Manovich's view of three dimensional spaces as being void until objects are added. This three dimensional space exists once objects are added, yet its invisible structure is the Cartesian grid.

I have created a unified three dimensional pictorial space. The black background of the three dimensional computer environment and the three layers of oil paint textures have merged to unify the picture plane. Fragments of paintings, geometric hard edges and infinite black space have created a cohesive three dimensional digital painting. I have dissolved the foreground and background into the one pictorial space using transparency and Davies uses this method as a unifying device in her virtual environments. I have created a homogenised pictorial space that unifies the three dimensional object with the void that exists around it, as outlined by Panofksy in Renaissance pictorial space. I have challenged Manovich's assertion that three dimensional space is void, and the three dimensional objects in this space have no relationship to this void. I have done this by using transparent digital oil paint textures, which revealed the background or void through them. This created a unity of object and background.

With the four portraits and the four computer generated environments completed, I combined them into a multimedia installation called CAVE Painting. Each of the four three dimensional immersive environments had textures taken from a specific portrait. Each three dimensional computer environment had four wireframes, three of them had textures derived from the portraits, and the final one was a white circular texture. The white circular texture overlaid the real painting. The layer that was closest to the viewer when projected had a square hole cut into it. This was a framing device for the real painting, and it created a sense of depth into three dimensional pictorial space by revealing more of the background. The white circular texture sat furthest in the background and illuminated the real painting hanging in the middle of the visual screen in CAVE Painting. Each three dimensional environment layout was the same. This ensured uniformity when all four portrait paintings, and their corresponding three dimensional environments, were displayed in a cube formation.

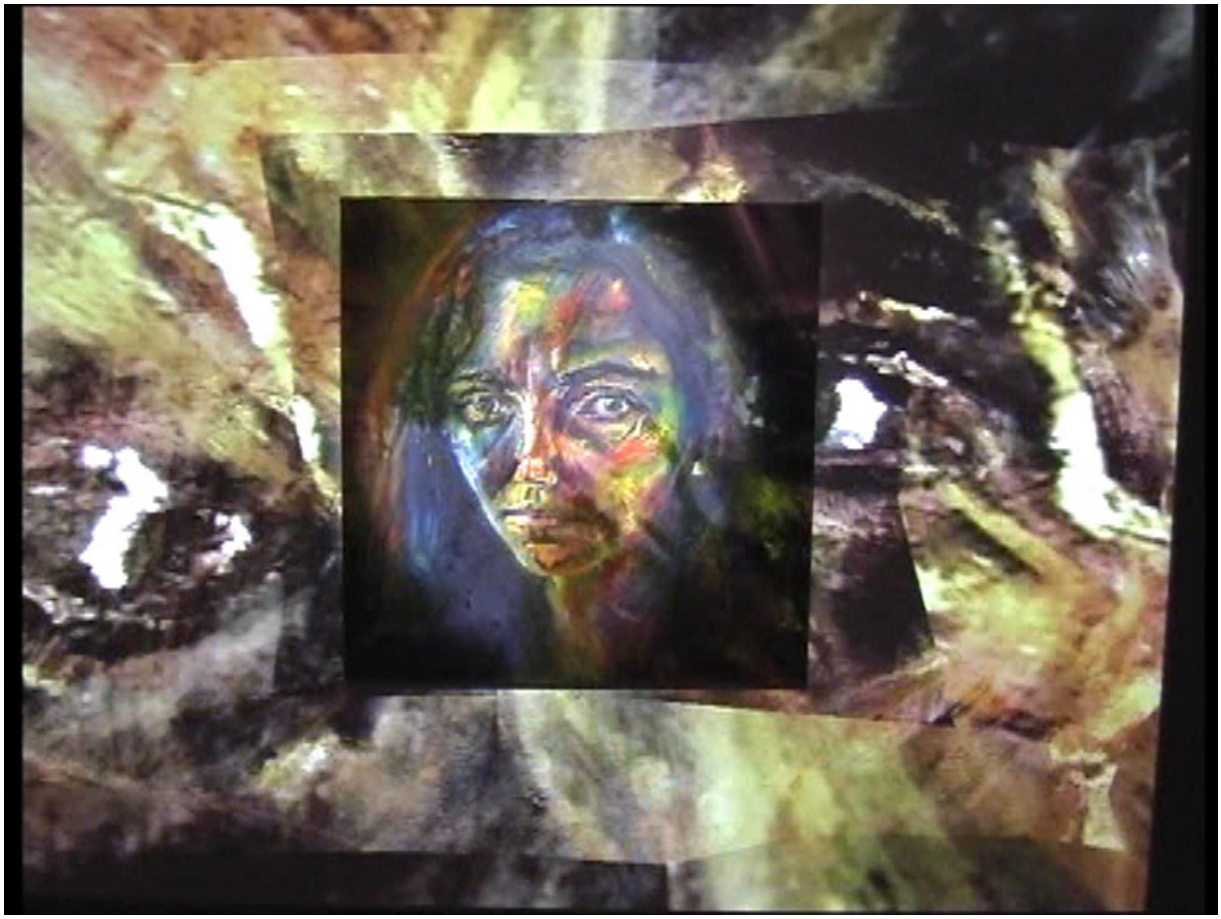
All of the four three dimensional environments moved in exactly the same way, maintaining uniformity of pictorial space. I created a homogenous pictorial space like that of Panofsky's Renaissance space. The four paintings remained static, whilst the three dimensional environments were projected onto and around the real paintings. This gave the illusion the real paintings were animated. Thus it illustrated Davies' intention to show the brushstroke moving in virtual space.

The movement in the projections was slow and gentle, giving the viewer time to absorb the detail in the real paintings and three dimensional virtual environments. The movement was based around Davies' definition of virtual space as being "as a spatiotemporal arena wherein mental models or abstract constructs of the world can be given virtual embodiment – visual and aural – in three dimensions and be animated through time".[108] Unlike Davies' virtual environments which are interactive, the imagery of CAVE Painting was not able to be explored. It was intended to be viewed as if looking at a two dimensional painting on a wall. There were four visual screens that surrounded the viewer in a CAVE environment. This CAVE environment was in a real physical space that was viewed by several people at a time. This created a feeling of semi immersion and not a total body immersion that Davies achieves using her head mounted display.

In summary, the portraits in CAVE Painting were done with oil paint which is a tactile physical substance. Flesh is represented in oil paint, and I drew on the techniques of Auerbach and Freud to achieve this. The portraits represent the artist's engagement with the live model. The computer generated environments of CAVE Painting represented the ephemeral nature of three dimensional computer based pictorial space which is time and light based, and immaterial. This was presented in McRobert's CAVE environment that surrounded the viewer

[108] Davies, Char. *Virtual Space*. 2004. p.2

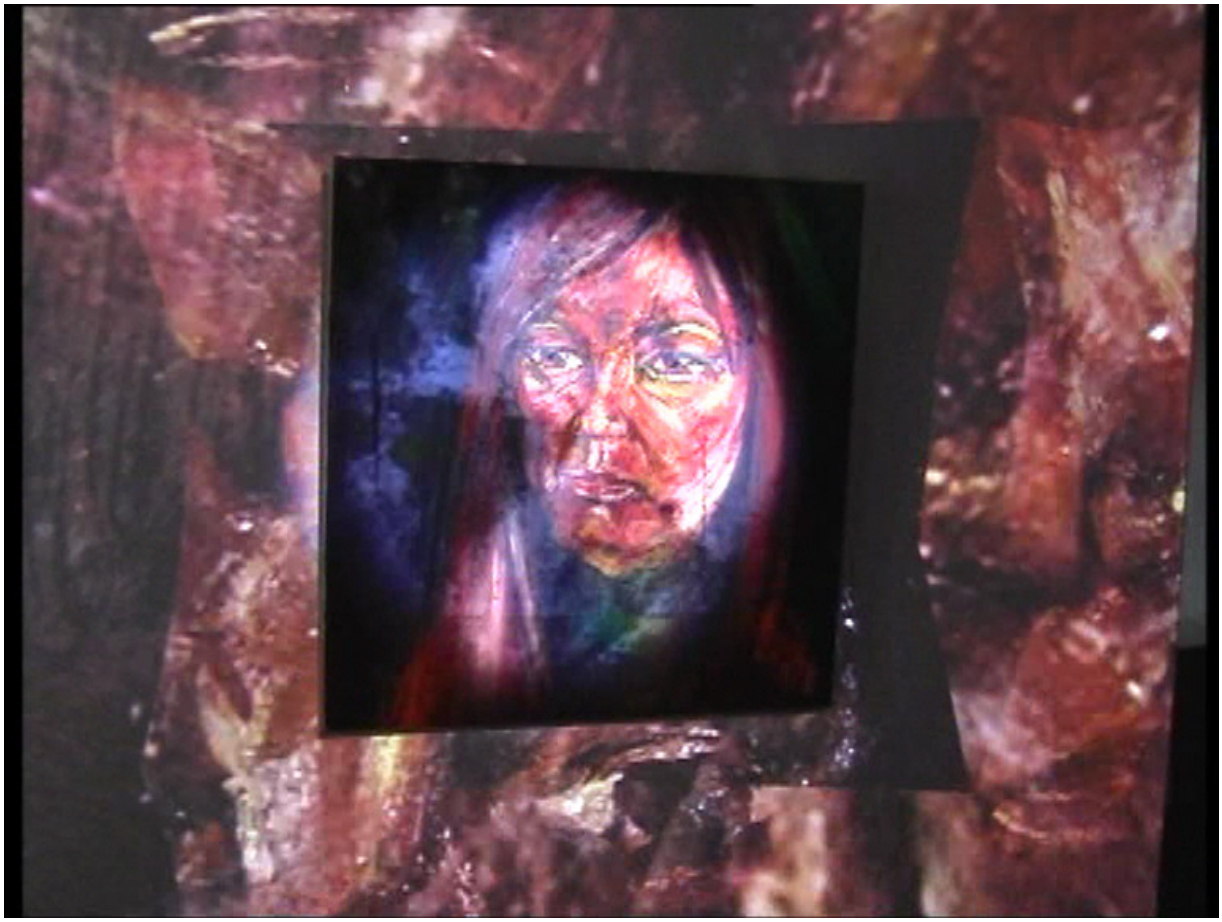
in a real space. I combined the real object with the virtual object, creating a mixed reality installation. This was based on Milgram and Kishino's theory of mixed reality. The four three dimensional environments were united with their corresponding four portraits to construct a hybrid of two dimensional Renaissance and three dimensional computer Cartesian pictorial space. Thus there was a marriage of two and three dimensional pictorial space, illustrating Manovich's proposition that Renaissance perspective has directly influenced three dimensional computer generated space. I united the portraits and three dimensional virtual environments in a semi immersive multimedia installation. The CAVE Painting installation was primarily to be viewed in a semi immersive space, with strong links to the tradition of figurative oil painting developed in the Renaissance era.



4.9 Three dimensional computer projection and oil painting on canvas (Julie). One of the four walls of CAVE Painting. 163 by 123cm. RMIT University, 2010.

4.10 Three dimensional computer projection and oil painting on canvas (Laurie). One of the four walls of CAVE Painting. 163 by 123cm. RMIT University, 2010.

4.11 Three dimensional computer projection and oil painting on canvas (Matt). One of the four walls of CAVE Painting. 163 by 123cm. RMIT University, 2010.



4.12 Three dimensional computer projection and oil painting on canvas (Carla). One of the four walls of CAVE Painting. 163 by 123cm. RMIT University, 2010.

CHAPTER FIVE

5. Conclusion

It was intended to develop a lineage, beginning with Euclid's theorems of parallel lines converging at a vanishing point, following with Renaissance perspective developed by Alberti, and ending with the Cartesian coordinate system developed by Rene Descartes'. It was found that there is a direct relationship between two dimensional pictorial space, as illustrated in my portraits, and three dimensional pictorial space, as illustrated by the three dimensional immersive environments, that make up the multimedia installation called CAVE Painting. Renaissance perspective, based on mathematical principles, has directly influenced the construction of three dimensional computer generated environments based on the Cartesian coordinate system. This has led to a hard-edged and geometric depiction of three dimensional pictorial space that had its beginnings in the Renaissance era.

CAVE Painting uses and challenges this hard-edged and geometric depiction of three dimensional pictorial space. It attempts to replicate the artist's painterly touch on canvas translated into three dimensional computer generated environments. I have used Auerbach's and Freud's painterly and textural application of oil paint on a two dimensional surface as a model in the construction of the portraits. The artist's brushstroke represents the intuitive, psychological paradigm which challenges a bias based solely on the geometrical construction of space. This was organic approach to painting was carried over into the three dimensional computer generated environments. This enabled the artist's brushstroke to become part of the three dimensional computer generated environment.

Renaissance perspective was found to be limiting in capturing the movement and subtle nuances of the human form. In describing the figure on canvas no lines of perspective were used, as this would have led to a preordained composition. Instead, having the knowledge of how Renaissance perspective is used was useful in achieving pictorial depth, and challenging its premise of geometrical ordering of space. As well, it was useful in understanding how to construct a uniform and infinite pictorial space as outlined by Panofsky. This idea of a homogenous pictorial space was achieved in the paintings and carried through to the three dimensional computer environments. Panofsky's view of pictorial space as being non-linear was useful in subverting the hard-edges that are evident when perspective is used. In the portraits hard edges were not painted but curved brushstrokes were used instead.

Char Davies' approach to constructing three dimensional computer generated environments by reinforcing the natural world and the body was utilised as a model. Integral to CAVE Painting was a connection of the artist engaging with the live model via oil painting, and digitising the paint textures and replicating it in three dimensional pictorial space. As well,

Davies' definition of virtual space as " a spatiotemporal arena wherein mental models or abstract constructs of the world can be given virtual embodiment – visual and aural – in three dimensions and be animated through time", was used in developing the three dimensional environments.[109] The digitised paint textures were animated in real-time in the game engine software.

The three dimensional environments were constructed so as to challenge Manovich's proposition that three dimensional space is void, and the objects created in this void bear no relationship to this space and each other. This was achieved by using transparency, a device Davies uses, to create a unity between the foreground and background. This uniform pictorial space is evident in two dimensional painting, but can be lacking in three dimensional pictorial space. This lack of unity of object to the space around it is a product of the three dimensional computer software that creates mathematical boundaries based on the xyz coordinates. Space around the object is void until objects are created, and the Cartesian grid creating an invisible structure for these objects. It is the objects themselves that define the space.

CAVE Painting is a multimedia installation that merged real objects, as illustrated by the portraits, and virtual space, as illustrated by the three dimensional computer immersive environments. The installation was based on Kishino and Milgram's definition of mixed reality which involves completely graphic displays but partially immersive environments (large screen displays) in which real physical objects in the user's environment play a role in the computer generated scene.[110] This was achieved by using four large screens with the portraits in front of each screen, and the three dimensional computer generated environments projected onto the screens and portraits. It was intended that the strength of two dimensional painting is that it is object based and tactile. The aesthetic pleasure of viewing the real brushstroke is paramount.

A CAVE environment, as defined by McRobert, was utilised as a framework in CAVE Painting to create a sensation of semi immersion. It was also used to maintain a link with real physical space, as not to completely disorient the viewer. I chose not to use Davies' head mounted display as that could have led to a more disembodied experience. I wanted to reinforce the link that two dimensional painting has to a real physical space, but provide a more immersive experience that surrounds the viewer. The three dimensional computer generated environment was a framework on which the practice of painting from life has been hung. This three dimensional digital space has the potential to immerse the viewer more fully into an artwork, whereas two dimensional painting can be limited in its ability to fully immerse

[109] Davies, Char. *Virtual Space*. 2004. p.2
[110] Kishino, Fumio and Milgram, Paul. *A Taxonomy of Mixed Reality Visual Displays*,1994, p.4

the viewer. Being transported inside an artwork provides a heightened experience of this artwork, and three dimensional computer technologies may provide the way in this regard.

It was shown that oil painting and three dimensional computer generated environments, being both material and immaterial, can coexist in CAVE Painting while remaining distinct entities. It provides the viewer with a sense of being encapsulated in a three dimensional painting, yet still showing traces of the original two dimensional painting. Real space and virtual space, oil painting and three dimensional computer generated projections coexist with one another. One is not mutually exclusive of the other; there is a symbiotic relationship between two and three dimensional pictorial space leading to a multimedia installation that is semi immersive.

The aim of Cave Painting was to combine two dimensional and three dimensional pictorial space to provide a semi immersive experience. Oil painting coupled with computer technology can lead to a greater sensation of immersion. CAVE Painting represents a nod in the direction of fully immersive three dimensional virtual space. Today's three dimensional computer generated space is illusory. Three dimensional computer generated pictorial space is still displayed on flat two dimensional surface, such as the visual display screen or computer. The level of immersion has increased via advances in technology, but we have yet to conquer the art of representing three dimensional computer generated pictorial space in real physical space. A three dimensional computer generated environment may be able to be displayed in real space in the future. The viewer will be able to manipulate and interact with this environment. Artwork may eventually become fully immersive, wherein the viewer will experience it in real space, and it will be able to be manipulated by touch, movement and voice recognition.

5.1 Future Research

Further research will need to be done in producing three dimensional computer real time software for artists. This software will need to be intuitive and user friendly. It will need to be constructed in such as way as to mimic the intuitive process of painting in two dimensions, where the background and objects are unified. This three dimensional real time space will be manipulated by touch and movement, creating a digital three dimensional painterly brushstroke. This would occur in a CAVE environment connected to other remote CAVE environments. The artist would be able to be inside this CAVE, and produce real time painting in three dimensions. This three dimensional space would be a participatory space, where several artists could collaborate on one piece at different physical locations. This CAVE environment will also allow the participant to explore and interact with the artwork in real time, which is not possible with two dimensional painting.

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